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Scientific, Technical and Economic Committee for Fisheries (STECF)

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Technical measures (STECF-17-02)

Edited by Dominic Rihan & Hendrik Doerner

This report was reviewed by the STECF during its 54th plenary meeting held from 27 to 31 March 2017 at JRC, Ispra, Italy

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Joint Research Centre

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Abstract

Commission Decision of 25 February 2016 setting up a Scientific, Technical and Economic Committee for Fisheries, C(2016) 1084, OJ C 74, 26.2.2016, p. 4–10. The Commission may consult the group on any matter relating to marine and fisheries biology, fishing gear technology, fisheries economics, fisheries governance, ecosystem effects of fisheries, aquaculture or similar disciplines. An Expert Working Group of the STECF was convened to develop guidelines for future evaluations by STECF of alternative technical measures that deviate from the baseline standards established at European Union level.

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EWG-16-14 report:

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Background provided by the Commission

As part of the Commission proposal on Technical Measures, baseline measures that establish core selectivity standards are defined for each regional sea basin. These are included in a set of regional annexes. The baseline measures are based on the substance of the existing technical rules for mesh sizes and catch composition rules, minimum conservation reference sizes, closed areas and nature protection type measures.

These baselines or default technical measures would be applicable unless and until regionalised measures are designed and introduced into Union law (through Delegated Acts) as part of multiannual plans or temporary discard plans. The proposal envisages that regional groups of Member States would be able to introduce alternative technical measures to these baselines on the basis that it can be demonstrated that these measures deliver similar (equivalent) conservation benefits in terms of exploitation patterns and level of protection for sensitive species and habitats to those they are intended to replace. It is assumed that STECF would have the role to establish whether the evidence provided by Member States to justify the use of such alternative measures sufficiently demonstrates equivalence to the baseline measures.

The Commission proposal envisages two potential scenarios.

1. Where a baseline technical measure is to be replaced with an alternative gear based technical measure (e.g. replacing the *baseline gear* with an alternative selective gear incorporating a device such as a square mesh panel or sorting grid).
2. Where there is deviation from a *baseline technical measure* (i.e. change in baseline mesh size or change in mcrs) based on the introduction of an alternative measure such as an area or seasonal closure or a move to fully documented fishery approach where technical rules may not be needed.

Terms of Reference for EWG-16-14

The objective of EWG 16-14 was to develop guidelines for future evaluations by STECF of alternative technical measures that deviate from the baseline standards established at Union level. Recognising that such measures may impact differently on different species and have different environmental impacts, the EWG is asked to consider appropriate mechanisms to determine whether the alternatives in aggregate are equivalent to those they are replacing, cognisant that the measures may impact differently on some species or fisheries.

For both of the scenarios listed in section 1, the EWG was requested to:

- Provide guidance on the data and information needs for the two types of scenarios to demonstrate equivalence using practical examples from different sea basins;
- Identify appropriate procedures and metrics for determining equivalence between different technical measures; and
- Consider species specific and broader environmental consequences, which should be factored in when deciding whether equivalence has been demonstrated or not.

Request to STECF

STECF is requested to review the report of the STECF Expert Working Group (EWG) meeting, evaluate the findings and make any appropriate comments and recommendations.

STECF response

Introduction

EWG 16-14 has proposed a draft framework for the evaluation of proposed alternative technical measures on the basis that regional groups of Member States would want to introduce alternative technical measures to the baselines. The general principle is to set out a mechanism by which alternative technical measures to those defined as the baseline can be efficiently evaluated and implemented. The motivation to introduce alternative measures will include a preference for other measures that deliver similar (equivalent) or those that have enhanced conservation benefits, in terms of exploitation patterns and level of protection for sensitive species and habitats, to those they would replace.

In each of the regional annexes the following baseline technical measures have been drafted (http://eur-lex.europa.eu/resource.html?uri=cellar:41312a57-e771-11e5-8a50-01aa75ed71a1.0024.02/DOC_2&format=PDF):

- Mesh sizes
- Minimum Conservation Reference Sizes (MCRS)
- Closed or restricted areas
- Mitigation measures for protection of sensitive species and habitats
- Introduction of innovative fishing methods (only in the North Sea)

The EWG 16-14 provides an overview of the methods to compare technical measures. This constitutes the main focus of the EWG 16-14 report and includes a priori and ex-post evaluations of technical measures. The methods are intended to provide guidance for Member States, the Advisory Councils and the fishing industry on the methods and evidence needs to enable comparisons to be made between technical measures. EWG 16-14 identified four main criteria to establish equivalence. Depending on the measure involved these criteria have a greater or lesser importance. For example Real Time Closures could influence size composition in catches (e.g. by closing areas of high abundance of juveniles), but are not so readily applicable to situations where a habitat in a particular location requires to be protected. A matrix summarising the potential relative impacts of different types of technical measure change on features of target and other fish populations and benthic habitat is provided, Table 3.2.2 of the EWG.

These criteria are in terms of:

- Exploitation pattern
- Exploitation rate
- Species Composition
- Habitat effects

The EWG 16-14 report comprehensively reviews the methods by which fishing gears can be compared. The methods of determining equivalence between gears are well established and direct. To establish equivalence or likely outcome of other technical measures (MCRS, closed or restricted areas, mitigation measures for protection of sensitive species and habitats, introduction of innovative fishing methods) is more challenging, the methods are less direct and this is reflected in the report. The EWG 16-14 report provides tables on the types of technical measures and the associated impacts. The EWG emphasises the need to define a clear management aim as a first step when considering alternative technical measures:

- Step 1: Defining the objective and setting the criteria for measuring equivalence
- Step 2: Evaluation of supporting information (A priori assessment)
- Step 3 (if positive assessment in step 2): Monitoring requirements for the alternative gear introduced (ex post assessment)

The EWG 16-14 states that it attempted to balance the need for a robust assessment without being overly prescriptive on the types or amount of supporting evidence that is required to support a proposal to use alternative measures. The importance of not stifling innovation is stated. For example, it is envisaged that, in the event of a limited initial trial, implementation could progress but there would be a greater requirement to put in place close monitoring of the outcome together with the ability to rapidly halt the use of the measure. This would compare with a situation where a high quality and exhaustive trial had demonstrated the suitability of a new measure and where ongoing monitoring was more 'light touch' and less demanding.

STECF comments

STECF acknowledges that the EWG addressed all the Terms of Reference under a tight time schedule. It is recognised that the aim of this EWG complements the broader work being undertaken to address the recognised weaknesses in the existing technical measures (http://eur-lex.europa.eu/resource.html?uri=cellar:41312a57-e771-11e5-8a50-01aa75ed71a1.0024.02/DOC_1&format=PDF), which have been summarised as:

- Sub-optimal performance as the technical rules do not incentivise selective fishing
- Difficult to measure effectiveness
- Prescriptive and complex rules
- Lack of flexibility
- Insufficient involvement of key stakeholders in the decision-making process
- difficult, lengthy and unclear process by which a new gear can be agreed

In terms of assessing equivalence or performance of technical measures relative to baselines, STECF notes that there is a requirement to have clearly defined, unambiguous details of the baseline technical measures. Details of the regional baseline measures were supplied separately and are available at http://eur-lex.europa.eu/resource.html?uri=cellar:41312a57-e771-11e5-8a50-01aa75ed71a1.0024.02/DOC_2&format=PDF. The baseline technical measures follow the same format as in earlier regulations that describe these measures for, i) Minimum Conservation Reference Sizes (MCRS), previously Minimum Landing Sizes, ii) closed or restricted areas, iii) mitigation measures for protection of sensitive species and habitats and iv) introduction of innovative fishing methods (only in the North Sea).

These definitions include the technical requirements associated with fishing operations, however, they do not identify a measurable impact of the individual measures and more importantly, they do not specify the management aim of the measures. In proposing any alternative measure it would be necessary to provide some context to the baseline measures which the alternative measures amend or replace to clarify their purpose. Without this information, STECF would not be able to evaluate the alternative measure as there would be nothing to base their evaluation on.

For the baseline technical measure relating to static net and cod end mesh sizes, STECF recognises the need to simplify the existing detailed and prescriptive regulations on fishing gear and to remove the link with catch composition regulations, as required with the implementation of the Landing Obligation. The gear-based technical regulations are presented in a format that differs from previous documents. The mesh size baselines are defined by region, for cod end or static gear, and by the conditions under which a smaller mesh sizes can be used. These conditions refer to 'directed' fisheries, for example, for cod end mesh sizes in the North Sea and Skagerrak/Kattegat, directed fishing for *Nephrops norvegicus* can use cod mesh of 80mm. The fine detail regarding the construction and operation of gears is proposed to be developed in Commission Implementing Acts rather than contained in the framework proposal. This is to make it easier and quicker to amend technical details.

STECF observes that in the Commission proposal, the mesh sizes proposed for each region in most cases are defined in terms of "directed" fisheries. "Direct fishing" is defined in the proposal as "*fishing for a defined species or combination of species where the total catch of that/those species makes up more than 50% of the economic value of the catch*". This is currently under negotiation with the Council and the European Parliament so this definition may change. Regardless, STECF considers there is a requirement to link the baseline mesh sizes to some form of metric. A clear definition of 'directed fishing', to understand precisely the conditions when this mesh size is being used is important, and this will need to be confirmed before the EWG guidance can be applied; the effect of an alternative measure can only be understood once it is known to which vessels and fisheries it will apply.

STECF observes that the EWG has not considered socio-economic implications of the implementation of alternative technical measures. The successful implementation may depend on possible negative or positive economic impacts of a change in measures. The EWG participants expect that the proposal for a change in technical measures will only be issued after the assessment of socio-economic impacts. STECF notes that only the inclusion of stakeholders in

particular from the fishing sector in the development process of the new technical measures and in a possible assessment of socio-economic impacts would most likely fulfil such an expectation.

STECF strongly supports the importance of not stifling innovation and providing guidance that will assist regional groups to evaluate options and enable flexibility in applying technical measures. STECF agrees that while there is substantial material in the EWG 16-14 report on the evidence requirements for comparing fishing gears, comparisons with and between other technical measures is more challenging. Further development of the EWG 16-14 report is thus needed to generate clear guidance that would assist regional groups in evaluating technical measures. The guidance would aim to facilitate regional groups in the selection and assessment process for alternative technical measures, avoid unnecessary evidence collection and assist STECF in evaluating proposed alternative measures. As a central part of the guidance, it would be useful to emphasise the balance of risk and evidence need, whereby evidence requirements should balance the likelihood of negative impact. Specifically, this guidance should include ecosystem indicators and gear impact evidence from research projects such as EU FP7 BENTHIS. There would be benefit in presenting the guidance as a simple stepwise process or decision tree that assist regional fisheries managers in formulating proposals. This would include:

- the requirement for a clear management aim of the alternative measure in the context of the aim of the existing measure
- a quantified objective of the alternative technical measure
- the basis for selecting the alternative measure (appropriateness, practical suitability, control mechanism, industry support)
- precise details of the measure
- assessment of risk against the four evaluation criteria to determine the a priori need for evidence (could be very low where risk is low)
- an evaluation based on a priori evidence of performance/equivalence
- an economic assessment
- an ex post evaluation plan
- post implementation assessment in the context of the quantified objective and management aim

STECF conclusions

STECF concludes there is a requirement to ensure there is clear definition of what constitutes "directed fishing" to allow evaluation of alternative gears to the baseline technical measures related to mesh size. STECF suggests that defining what constitutes "directed fishing" would be best defined regionally and aligned with the conditions in of the baselines as these may differ between regions.

STECF concludes that the EWG 16-14 report would benefit from refinement and could be presented in a more end-user friendly guidance format. Revised guidance would aim to be a useful tool for regional groups, to identify risk, avoid unnecessary evidence collection, and assist STECF in evaluating proposed alternative technical measures. STECF stresses that new measures need to be an improvement or at least an equivalent to the baseline.

STECF emphasises that, to allow evaluation by STECF, the objectives of the baseline measures are clearly defined in any application for an alternative measure. Without this information there is no basis against which to asses an alternative measure.

STECF suggests that further enhancement to the guidance is needed on evaluating non-gear based technical measures considering ecosystem indicators and known habitat impacts of gears. This would need to be linked with the indicators from the Marine Strategy Framework Directive MSFD (Table 2 of Annex III).

STECF concludes that the Advisory Councils ACs should be included in the process of the development of the alternative technical measures. The quality of the proposed new measures would benefit from direct inclusion of stakeholders in the development process within the regional groups. Within this process an assessment of the socio-economic impacts should be conducted.

STECF concludes that further work is needed to complete a final draft guidance document (including guidance on how to evaluate the socio-economic impact) that can be used by regional groups. STECF proposes that a follow-up EWG could be set up for this purpose.

The EWG-16-14 report was reviewed during the 54th plenary meeting held from 27 to 31 March 2017 at JRC, Ispra, Italy.

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REPORT TO THE STECF

EXPERT WORKING GROUP ON Technical Measures (EWG-16-14)

Brussels, Belgium, 6-10 February 2017

This report does not necessarily reflect the view of the STECF and the European Commission and in no way anticipates the Commission's future policy in this area

1. EXECUTIVE SUMMARY

In March 2016 the European Commission adopted a proposal (COM (2016) 134) that aimed to revise the current technical measures regulations applying across Union waters and the outermost regions. As part of this proposal, baseline measures that establish core selectivity standards are defined for each regional sea basin. These are included in a set of regional annexes. The baseline measures are based on the substance of the existing technical rules for mesh sizes and catch composition rules, minimum conservation reference sizes, closed areas and nature protection type measures. They would be applicable unless and until regionalised measures are designed and introduced. The proposal envisages that regional groups of Member States would be able to introduce alternative technical measures to these baselines on the basis that it can be demonstrated that these measures deliver similar (equivalent) conservation benefits in terms of exploitation patterns and level of protection for sensitive species and habitats to those they are intended to replace. STECF would have the role to establish whether the evidence provided by Member States to justify the use of such alternative measures sufficiently demonstrates equivalence to the baseline measures.

EWG 16-14 has considered two potential scenarios envisaged by the Commission:

3. Where a baseline technical measure is to be replaced with an alternative gear based technical measure (e.g. replacing the baseline gear with an alternative selective gear incorporating a device such as a square mesh panel (SMP) or sorting grid).
4. Where there is deviation from a baseline technical measure (i.e. change in baseline mesh size or change in MCRS) based on the introduction of an alternative measure such as an area or seasonal closure or a move to fully documented fishery approach where technical rules may not be needed.

The motivation for proposing alternative measures may arise for several reasons. Most likely would be for economic reasons in that the existing measure does not provide an acceptable solution for the fishery (or vessels) to meet the business need. Measures could also be proposed because the existing measure does not provide optimal resource utilisation. In certain circumstances it may also be the case that an alternative measure (e.g. gear modification) is identified and provides an improved solution, but does not fully deliver equivalence with the baseline (i.e. alters the exploitation pattern) so an additional alternative measure (e.g. a closed area) is needed to offset the deviation.

EWG 16-14 has considered these reasons and developed a framework for evaluation of proposed alternative measures around them. This framework considers both a priori and ex-post evaluations. EWG 16-14 has also commented on additional unintended consequences that should be considered when evaluating alternative measures (e.g. ecosystem and economic impacts).

In developing the framework EWG 16-14 has balanced the need for a robust assessment without being overly prescriptive on the types or amount of supporting evidence that is required to support a proposal to use alternative measures. There is clearly an important message that this process needs to be dealt with on a case by case basis and where very obvious outcomes are achieved by a new measure the need for elaborate trials is reduced. It is important not to stifle or discourage innovation at an early stage.

In this regard EWG 16-14 suggests as a general principle, in the event of a limited initial trial to support the proposal, there should be a greater requirement to put in place close monitoring of the outcome together with the ability to rapidly halt the use of the measure. There is often a tendency to delay implementation of a new measure where an element of controversy repeatedly leads to requests that 'more science' is carried out. Trialling followed by careful monitoring of outcomes in a controlled fishery may be a more helpful approach.

EWG 16-14 has identified four main criteria to establish equivalence in terms of - exploitation pattern, exploitation rate, species composition and habitat effects. When thinking about new technical measure(s) (to replace an existing or to meet a new objective), there are essentially two steps. The first step is to say 'which technical measure is likely to achieve the management objective and provide the necessary equivalence". The second step is to say 'are there any impacts on other features of populations or habitat brought about by introducing the new measure that should be considered to ensure that equivalence is achieved across the board.

In the process of considering an alternative technical measure instead of applying a baseline measure or in pursuit of a defined management objective, at least two important steps need to be taken. The first step involves a consideration of the likely effectiveness of any adjustment to an existing measure (or new measure) to at least achieve equivalence with a baseline or to achieve a desired management outcome. Different types of technical measures have the capacity to achieve different aims and not all perform well in all circumstances. Assuming a preferred technical measure is identified, the second step is to consider the potential impact of that new measure on the various characteristics of fish populations and the habitat. It is conceivable that in achieving equivalence in the area of immediate interest (e.g. achieving the same or better selectivity with a fishing gear more suited to a fishing vessel's operations) another fish population characteristic or the environment is adversely affected so that equivalence is not in fact achieved.

In evaluating gear-based measures, EWG 16-14 notes there are several metrics – selectivity parameters, catch comparison rates, catch ratios and proportion of unwanted catches - that can be used to evaluate the efficacy of a new or modified gear. It is important that when choosing a particular metric that it is measurable and reflects the aims and objectives that have motivated the introduction/development of the gear in question. The nature of the data that is available will dictate the choice of metric but also, the chosen metric will influence what type of data needs to be collected and what experimental trials need to be carried out (if any).

In terms of assessing and monitoring alternative gears, EWG 16-14 has identified a wide range of tools available for the evaluation and continued monitoring of alternative gears once introduced including self-sampling, observer programmes, REM, last-haul analysis and modelling techniques. All of these have their pros and cons and it is likely a combination of tools will be needed to monitor the impacts of alternative gears.

EWG 16-14 considers demonstrating equivalence for non-gear based measures is much more difficult than for selective gears. The assessment of these types of measures is complex and requires significant amounts of data to allow proper evaluation and continued monitoring.

The use of spatial and temporal measures will address all of the equivalence criteria identified by EWG 16-14. However, such closures may have unintended consequences in that by closing areas to fishing either permanently or temporarily could led to displacement of effort into other areas and also the possibility of creating gear conflicts between static gear and towed gears.

Real-time closures represent a flexible and highly responsive management measure that in the past has found favour with fishermen. However, the impact of real-time closures is difficult to assess and they require a significant amount of monitoring as evidence by the Scottish Conservation Credit Scheme.

RBM offers the possibility to deviate from the baseline measures completely, removing the need for technical rules it is likely that some safeguards will be needed to ensure that unintentional and accidental damaging effects on the stocks and environment do not arise. These safeguards should maintain minimum precautionary requirements for gears and practices, while setting the requirements low enough for fishermen to adjust their fishery to operate under an RBM system.

In certain circumstances or in specific fisheries changes in overall fishing effort could be used as a tool to replace a baseline gear or to mitigate against any detrimental effects arising from the use of a new technical measure. However, the resulting yield would be lower than the maximum yield that could be obtained with the gear before modification.

In establishing or amending MCRS the primary objective of ensuring the protection of juveniles of marine organisms and at the same time maximizing the potential of the resource by changing the exploitation pattern should be maintained. The metrics to be used to measure protection of juveniles should be clearly defined. For those stocks that are not currently subject to an MCRS, supporting information to justify the introduction of a MCRS would inform the decision on whether to accept such a provision and that such information should accompany the proposal. The EWG considers that proposals should provide information to demonstrate that the introduction of the proposed MCRS is likely to achieve the stated objectives

In introducing any alternative measure EWG 16-14 recognises that there may be unintended impacts that should be considered. These mainly relate to ecosystem and economic impacts. The EWG has commented on both of these although a more detailed analysis may be required.

EWG 16-14 considers that while the introduction of an alternative measure may have unintended ecosystem impacts such as on non-target species or sensitive habitats, in reality assessing all of these potential impacts will be very difficult and may not always be necessary. Therefore there needs to be a trade-off between the conservation benefits of the alternative measure and the potential for ecosystem impacts where information to allow a complete assessment is unavailable or the likely impacts are likely to be minimal. On the other hand, a gear may be assessed as having a lower impact than the baseline gear but may in fact still have significant impacts on the seabed due to a lack of clarity about the baseline gear the alternative gear is being tested against. The granting of an authorization to use such gears in both cases could lead to irreversible impacts on the habitat. In cases where it is clear that an assessment of the likely bottom impacts of a new gear should be assessed then EWG 16-14 suggest the quantitative framework to assess the impact of mobile fishing gear on the seabed and benthic ecosystem developed by Rijnsdorp et al (2016) could be used. This framework provides indicators for both trawling pressure and ecological impact.

With regard to economic impacts EWG 16-14 does not consider there is a need to assess the economic impacts of introducing alternative measures. It is assumed that Member States in conjunction with their respective fishing industries in bringing forward such measures will have already considered the economic implications.

In conclusion EWG 16-14 has completed an initial evaluation of the methodologies and data needed to demonstrate equivalence of alternative measures to baseline measure specified in legislation. However, particularly in respect of the non-gear based measures EWG 16-14 stresses that further work is needed to refine this into a framework that Member States could follow in proposing such alternative measures. In this regard, EWG 16-14 suggests a follow-up meeting of the EWG should be convened. Given the proposal for the technical measures framework is still under negotiation this follow-up meeting should only be held when there is a clearer picture of the detail of the final technical measures regulation.

2. INTRODUCTION

Technical measures are rules governing how and where fishermen may fish. They aim to control the catch that can be taken with a given amount of fishing effort and also to minimise the impacts of fishing on the ecosystem. They form an integral part of the regulatory framework of most fisheries management systems including the Common Fisheries Policy (CFP).

Technical measures can be grouped into:

- measures that regulate the operation of the gear;
- measures that regulate the design characteristics of the gears that are deployed;
- minimum sizes below which fish and shellfish must be returned to the sea;
- measures that set spatial and temporal controls (e.g. closed/limited entry areas and seasonal closures) to protect species aggregations of juvenile and/or spawning individuals; and
- measures that mitigate the impacts of fishing gears on sensitive species (e.g.marine mammals, seabirds and turtles) and habitats (e.g. corals, Posidonia meadows).

In March 2016 the European Commission adopted a proposal (COM (2016) 134) that aims to revise the current technical measures regulations applying in Union waters in the NE Atlantic, North Sea, Baltic, Mediterranean, Black Sea and outermost regions (See Annex 1). This proposal is currently under negotiation by the Council and European Parliament. It sets out a new approach to the regulation of technical measures. It aims to simplify the current measures by bringing them together in one regulation rather than multiple regulations. It adapts the governance structure of technical measures to embrace regionalisation, strengthens the long-term approach to conservation and resource management including tackling the discards problem. It also enhances stakeholder involvement and gives more responsibility to industry in developing future technical measures.

As part of the Commission proposal, baseline measures that establish core selectivity standards are defined for each regional sea basin. These are included in a set of regional annexes (See Annex 2). The baseline measures are based on the substance of the existing technical rules for mesh sizes and catch composition rules, minimum conservation reference sizes (MCRS), closed areas and nature protection type measures. These baselines or default technical measures would be applicable unless and until regionalised measures are designed and introduced into Union law (through Delegated Acts) as part of multiannual plans or temporary discard plans. The proposal envisages that regional groups of Member States, working with the Advisory Councils, would be able to introduce alternative technical measures to these baselines on the basis that it can be demonstrated that these measures deliver similar (equivalent) conservation benefits in terms of exploitation patterns and level of protection for sensitive species and habitats to those they are intended to replace. It is assumed that STECF would have the role to establish whether the evidence provided by Member States to justify the use of such alternative measures sufficiently demonstrates equivalence to the baseline measures.

The Commission proposal envisages two potential scenarios:

5. Where a baseline technical measure is to be replaced with an alternative gear based technical measure (e.g. replacing the baseline gear with an alternative selective gear incorporating a device such as a square mesh panel (smp) or sorting grid).
6. Where there is deviation from a baseline technical measure (i.e. change in baseline mesh size or change in MCRS) based on the introduction of an alternative measure such as an area or seasonal closure or a move to fully documented fishery approach where technical rules may not be needed.

2.1. Terms of Reference for EWG-16-14

The objective of EWG 16-14 is to develop guidelines for future evaluations by STECF of alternative technical measures that deviate from the baseline standards established at Union level. Recognising that such measures may impact differently on different species and have different environmental impacts, the EWG is asked to consider appropriate mechanisms to determine whether the alternatives in aggregate are equivalent to those they are replacing, cognisant that the measures may impact differently on some species or fisheries.

For both scenarios listed in section 1, the EWG is requested to:

1. Provide guidance on the data and information needs for the two types of scenarios to demonstrate equivalence using practical examples from different sea basins;
2. Identify appropriate procedures and metrics for determining equivalence between different technical measures; and
3. Consider species specific and broader environmental consequences, which should be factored in when deciding whether equivalence has been demonstrated or not.

Terms of reference 1 and 2 are dealt with in sections 3, 4 and 5 while term of reference 3 is covered in section 6.

3. BASIC APPROACH

The Commission proposal identifies the main instrument for establishing regional technical measures should be through multiannual plans as defined in the CFP. Within the context of multiannual plans the proposal envisages baseline standards may be:

- Amended; or
- New measures established to supplement or replace the baseline standards; or
- Measures that derogate from the baseline standards where it can be demonstrated the existing measures have no conservation benefit or that the alternative measures have been put in place that ensure the objectives and targets continue to be met.

Such regional technical measures should as a minimum be equivalent in terms of exploitation patterns and protection for sensitive species and habitats as the baseline standards.

In each of the regional annexes the following baseline measures are established:

- Minimum conservation reference sizes (MCRS)
- Mesh sizes
- Closed or restricted areas
- Mitigation measures for protection of sensitive species and habitats
- Introduction of innovative fishing methods (only in the North Sea)

Changes in mesh size, gear construction and innovative fishing methods relate to the scenario 1 described above, while, changes to MCRS, closed or restricted areas, mitigation measures for sensitive species relate to scenario 2.

Proposals for alternative measures may arise for several reasons:

- The existing measure does not provide an acceptable (economic) solution for the fishery (or vessels) to meet their business need;
- The existing measure does not provide optimal resource utilisation; or
- An alternative measure (e.g. gear modification) is identified and provides an improved solution, but does not fully deliver equivalence with the baseline (i.e. alters the exploitation pattern) so an additional alternative measure (e.g. a closed area) is needed to offset the deviation.

EWG 16-14 has considered these reasons and developed a framework for evaluation of proposed alternative measures around them. This framework considers both a priori and ex-post evaluations. EWG 16-14 also has identified additional unintended consequences that should be considered when evaluating alternative measures (e.g. ecosystem and economic impacts). In developing the framework EWG 16-14 has balanced the need for a robust assessment without being overly prescriptive on the types or amount of supporting evidence that is required to support a proposal to use alternative measures. It is important not to stifle or discourage innovation at an early stage.

In moving to a system where various management measures could potentially be deemed acceptable for achieving an objective, the important question is, 'how is a decision reached on whether equivalence has been achieved'? Typically, the collection of experimental data involves some error and variance in natural systems and practical applications - rarely is a result 'clear cut'. Rigorous scientific studies include a statistical design and analysis which may guide whether a statistical difference exists between a test situation and a control. Commonly, reference is made to 95% confidence limits and decisions are reached accepting a certain small level of uncertainty. Establishment of such trials can become prohibitively costly and the 'statistical power' implied by the design can create its own difficulties.

In the new approach to technical measures the requirements will most often be to achieve equivalence with a baseline situation or, if there is a clear 'improved' management objective being sought in any proposal, to demonstrate that the objective is achieved. Failure to set up an adequate trial could run the risk of dismissing or accepting equivalence, simply because inherent variability was too high and, by chance, led to a wide departure from equivalence. On the other hand, an extremely rigorous trial could dismiss (or accept) equivalence even though the

difference from the baseline was very slight (to all practical intents and purposes non-existent) simply because a high replicate number had generated a very 'powerful' test.

Dwelling on the detail of setting up such trials and attempting to prescribe hard and fast rules is unlikely to be productive and could well quickly kill the initiative to encourage the development of alternative measures. There is clearly an important message that this process needs to be dealt with on a case by case basis and where very obvious outcomes are achieved by a new measure the need for elaborate trials is reduced.

Perhaps a more helpful 'rule of thumb' relates to the additional requirement to monitor ongoing outcomes arising from the adoption of a new measure. One could envisage a general principle where, in the event of a limited initial trial, there was a greater requirement to put in place close monitoring of the outcome together with the ability to rapidly halt the use of the measure. This would compare with a situation where a high quality and exhaustive trial had demonstrated the suitability of a new measure and where ongoing monitoring was more 'light touch' and less demanding. This general principle arguably feeds across into the wider question of 'how much science is enough'. There is often a tendency to delay implementation of a new measure where an element of controversy repeatedly leads to requests that 'more science' is carried out. Trialling followed by careful monitoring of outcomes in a controlled fishery may be a more helpful approach.

The steps for evaluating such an alternative measures is shown in Figure 3.1 and described in more detail in sections 4 and 5. In all cases the procedure should follow the same three steps. The criteria used to assess equivalence will be different depending on the objective of the measure, the complexity and level of deviation of the alternative measure proposed in comparison to the baseline and also the nature of the fishery in which it is to be used. In submitting such proposals, EWG 16-14 considers all three steps should be addressed.

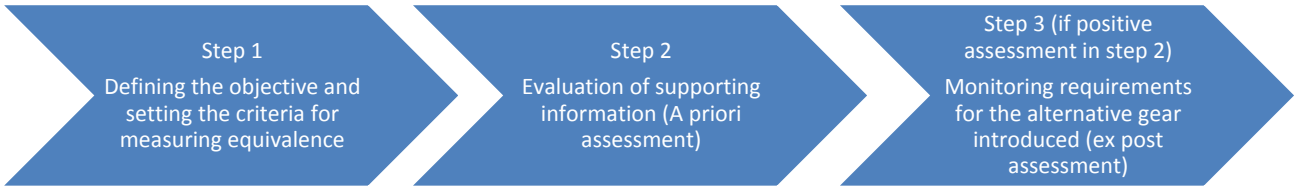

Figure 3.1 The Three steps in the evaluation process

3.1. Defining the objective

Fishing activity can be characterised by a series of questions - when, where, how, how much and for what? These basic questions drive decisions on management measures and provide a useful guide to the required steps in thinking ahead when proposing new measures. For example in a directed *Nephrops* fishery, the alternative gear could be to use a 70mm square mesh codend and a 120mm square mesh panel compared to the baseline 80mm codend with a 120mm square mesh panel. In this case the smaller square mesh codend could be demonstrated to give equivalent selectivity as the larger diamond mesh for the key species in the fishery.

Defining the objective of the baseline measure is an important first step as without a clear idea of what the baseline measure is designed to protect then there is no basis to evaluate an alternative

measure against. The objective will depend on the measure. For gear based measures the objective will most likely be to improve the selectivity of the gear for the target and/or the non-target species, whereas a non-gear based measure such as a closed area will have the objective to protect nursery areas, spawning aggregations or a sensitive species or habitat.

The focus of alternative measures will most likely be different depending on the regions. For instance the mixed demersal fisheries in NWW and the North sea as well as the cod fisheries in the Baltic lend themselves to the introduction of selective gears as potential solutions to bycatch problems, whereas in the SWW and Mediterranean the focus may be more on the introduction of permanent or temporary closed areas and the management of fishing effort, given the complexity of the fisheries and the number of species involved.

EWG 16-14 has developed a simple template (see table 3.1.1) for Member States to describe the proposed alternative measures. This template will also help in cases where only partial information or anecdotal references to studies conducted are provided.

Table 3.1.1 Template for the provision of information accompanying proposals for the use of alternative measures

Member States	Fishery description (species, area, fleets involved)	Baseline measure	Objective of baseline measure	Description of alternative measure proposed	Supporting information supplied

3.2.Criteria to establish equivalence

EWG 16-14 has identified four main criteria to establish equivalence. These are in terms of:

- Exploitation pattern
- Exploitation rate
- Species Composition
- Habitat effects

In the process of considering an alternative technical measure instead of applying a baseline measure or in pursuit of a defined management objective, at least two important steps need to be taken. The first step involves a consideration of the likely effectiveness of any adjustment to an existing measure (or new measure) to at least achieve equivalence with a baseline or to achieve a desired management outcome. Different types of technical measures have the capacity to achieve different aims and not all perform well in all circumstances. Table 3.2.1 provides a basic guide on the suitability of different measures to potentially achieve outcomes relating to a the equivalence criteria in terms of a variety of fish population characteristics and the habitat. The table indicates, for example, that where Real Time Closures could influence size composition in catches (e.g. by closing areas of high abundance of juveniles), they are not so readily applied to situations where a habitat in a particular location requires to be protected.

Assuming a preferred technical measure is identified, the second step is to consider the potential impact of that new measure on the various characteristics of fish populations and the habitat. It is conceivable that in achieving equivalence in the area of immediate interest (e.g. achieving the same or better selectivity with a fishing gear more suited to a fishing vessel's operations) another fish population characteristic or the environment is adversely affected so that equivalence is not in fact achieved. Table 3.2.2 illustrates the likely relative impact of different measures on the different features for which equivalence needs to be achieved. The stronger the shading the more likely the technical measure is to have an influence on that feature. The table helps to focus

where to place the most impact assessment work in order to identify adverse effects and thus areas where additional steps may need to be taken to ensure equivalence is achieved.

Table 3.2.1 Suitable candidate technical measures ('tools') which might be used to achieve equivalence in respect of different population or habitat features
'Yes' indicates that the technical measure 'tool' is likely to be helpful in addressing an equivalence problem arising in a particular feature. 'No' indicates the 'tool' is likely to be ineffective in dealing with the problem.

Type of Measure	Criteria to demonstrate equivalence for a non-baseline technical measure to be assessed					
	Exploitation pattern (Size/Sex Composition)	Exploitation rate (Total fishing mortality)		Species Composition		Habitat effects
	Refers to the fleet catch. Should be equivalent or better (case by case evaluation based on management targets)	Refers to each exploited species. Refers to the fish stock level. Should be equivalent or less. Relevant to assessed species. (case by case evaluation based on management targets)		Proportional presence of each species in the catch. Should be equivalent or better (case by case evaluation based on management targets)		Refers to the impact on the benthic habitats and communities
	All species	TAC species	Med/non-TAC/ protected species	TAC species	Med/non-TAC/ protected species	All species
Gear modifications/replacements	YES	YES	YES	YES	YES	YES
Closures of areas with specific characteristics (nurseries/spawning grounds/aggregations)	YES	YES	YES	NO	NO	NO
Closure of areas with aggregations of unwanted species	NO	NO	NO	YES	YES	NO
Closure of areas with sensitive habitats	NO	NO	NO	NO	NO	YES
Halt fishing during recruitment/spawning periods (temporal closure)	YES	YES	YES	NO	NO	NO
Real Time Closures	YES	YES	YES	YES	YES	NO
Move to RBM ensuring equivalent output with baseline	YES	YES	YES	YES	YES	NO
Reduction in fishing effort	YES	YES	YES	NO	NO	NO

Table 3.2.2 Potential relative impacts of different types of technical measure change on features of target and other fish populations and benthic habitat

The darker the shading, the greater the likely impact - Note the impacts may be positive or negative and the table does not imply that the impact is good or bad. Rather, the table highlights which features are likely to require the most attention when demonstrating equivalence of any particular candidate technical measure.

		Features for which equivalence of a non-baseline technical measure requires to be demonstrated					
Type of change		Size/Sex Composition (Exploitation pattern)	Total fishing mortality (Exploitation rate)		Species Composition		Habitat effects
		Refers to the fleet catch. Should be equivalent or better (case by case evaluation based on management targets)	Refers to each exploited species. Refers to the fish stock level. Should be equivalent or less. Relevant to assessed species. (case by case evaluation based on management targets)		Proportional presence of each species in the catch. Should be equivalent or better (case by case evaluation based on management targets)		Refers to the impact on benthic habitats. Both sensitive and common ones
			TAC species	Med/non-TAC/protected species	TAC species	Med/non-TAC/protected species	
Gear changes	Gear modifications/replacements						
MCRS	Change in MCRS						
Spatial Changes	Closures of areas with specific characteristics (nurseries/spawning grounds/aggregations)						
	Closure of areas with unwanted species						
	Closure of areas with specific habitats						
	RTCs						
Temporal Changes	Halt fishing during the recruitment/spawning period						
Results-based management (RBM)	Move to RBM						
Overall effort (appropriate to fishing technique)	Reduce fishing effort						

4. SCENARIO 1 – GEAR BASED

In this section the evaluation methodology and metrics that STECF could use to evaluate equivalence of alternative gear based measures are described. The methods that could be used to monitor and evaluate such measures once implemented by Member States are also set out. In addition some worked examples are provided to illustrate how an evaluation could be carried out in practice and the type of advice STECF could supply.

4.1. Evaluation methodology and metrics

There are many metrics that can be used to evaluate the efficacy of a new or modified gear. It is important that when choosing a particular metric that (i) it is measurable and (ii) it reflects the aims and objectives that have motivated the introduction/development of the gear in question.

The nature of the data that is available may dictate the choice of metric but also, the chosen metric will influence what type of data needs to be collected and what experimental trials need to be carried out (if any).

Here we present some of the possible metrics that could be used by STECF to assess the data that come from gear selectivity and catch comparison experimental trials when demonstrating equivalence.

4.1.1. Selectivity metrics

The traditional metrics of gear selectivity that can be used to monitor the success of an alternative gear/technical measure are length of 50% retention (L50) and selection range (SR) (Wileman et al. 1996). These metrics are absolute measures that are population-independent. They can be either length or age based and can be used to directly compare the selective performance of different gears. In general, a more selective gear would have a greater L50 and perhaps a smaller SR, both of which would result in the capture of less undersized fish (Figure 4.1.1).

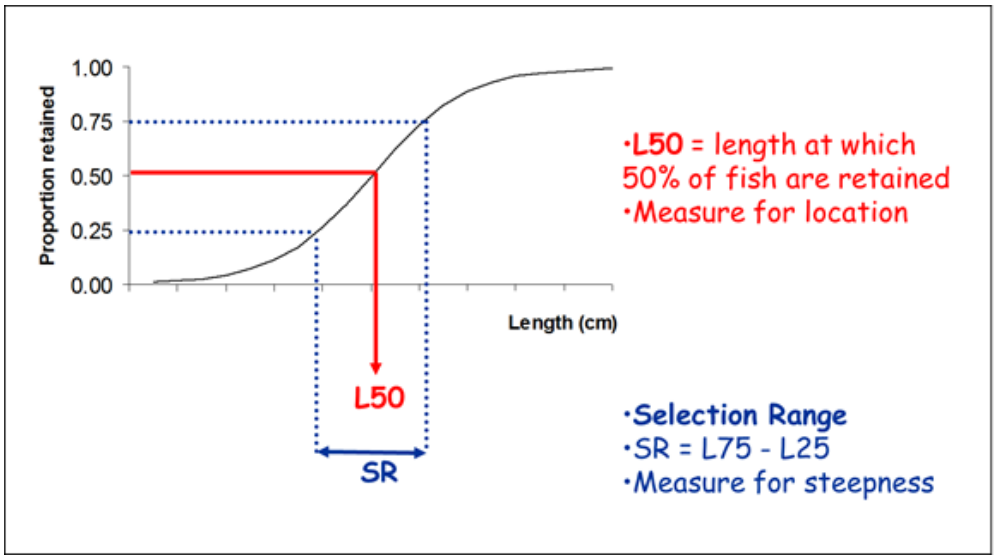

Figure 4.1.1 A logistic curve that is often used to characterise the proportion of fish retained in a gear

There are many other types of metrics that directly compare the catches of different gears or quantify, in some way the catch profile of a particular gear. For example, studies may compare the **catch comparison rate**, (*CC),* of an experimental gear (gear type a) and of the traditional (gear type b) as described below:

$$cc = \frac{\sum n_a}{\sum n_a + n_b}$$

where n_a and n_b are the total number of fish caught by gears *a* and *b* respectively.

If the catch efficiency of gears *a* (experimental) and *b* (traditional) are equal, and the number of hauls conducted are the same, then the expected value of the summed catch comparison rate is 0.5. The catch comparison rate (*CC)* cannot be used to quantify directly the ratio between the catch efficiency of gear *a* vs. gear *b*. Instead, the **catch ratio** *cr* can be used and expressed as follows:

$$cr = \frac{\sum n_a}{\sum n_b}$$

An advantage of using the catch ratio is that unlike the catch comparison rate it provides a direct relative value of the catch efficiency of gear *a* compared to for gear *b*. Thus, if the catch efficiency of the two gears is equal, *cr* should be 1.0. For example, *cr* = 1.25 would mean that gear *a* catches on average 25% more fish than gear *b*, whereas *cr* = 0.75 would mean that gear *a* catches only 75% of fish compared with gear *b*. The above metrics are based on specimen number but can just as easily be based on weight using the same formulae. Figure 4.1.2 shows an example of a catch comparison evaluation.

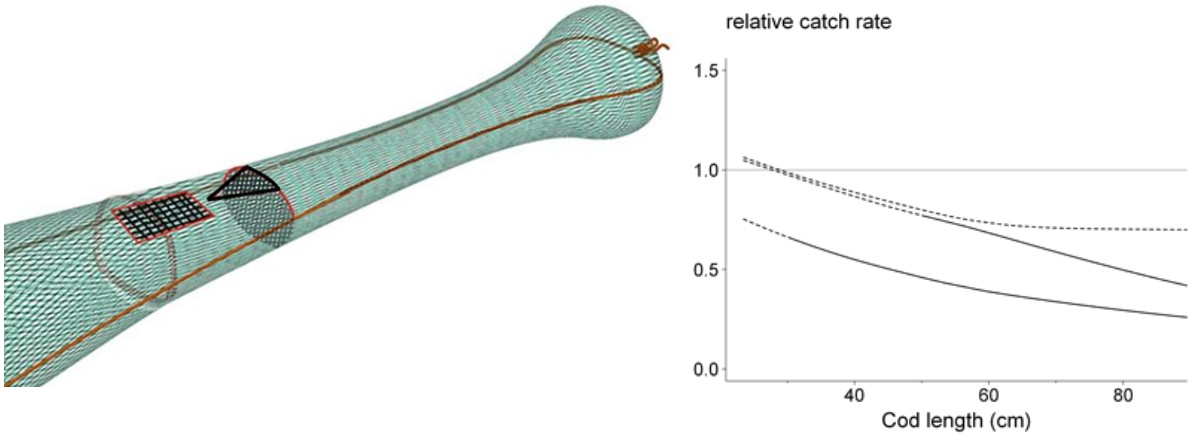

Figure 4.1.2 Kynoch et al (2012) showed that the catch ratio (cr) for cod of a gear using the FCAP netting grid in comparison to a standard gear was 0.38, equivalent to a reduction of 62%

Another metric that could be considered is the **proportion of unwanted catches** which refers to undersized fish, (i.e. fish with a size lower than the MCRS). With the introduction of the landing obligation it is highly likely that many new gears will be developed with the aim of reducing this component of the catch. In order to assess the effect of such new gears, the use of metrics centered on the MCRS may be particularly useful. The percentage of fish below MCRS can be expressed as follows:

$$rBMS_i = \frac{\sum_{i<MCRS} n_i}{\sum_{i=1}^{n} n_i}$$

Herrmann et al. (2012) and Sala et al. (2015) propose similar metrics for monitoring the effects of alternative gears. They define nP_- and $nP+$ as the proportion of individuals below and above

the MCRS retained by gears and *nRatio* as the ratio of these terms. These metrics can be calculated as follows:

$$nP- = 100 \cdot \frac{\sum_{\ell<MCRS} n_{CD\,\ell}}{\sum_{\ell<MCRS} n_{CD\,\ell} + n_{CV\,\ell}}$$

$$nP+ = 100 \cdot \frac{\sum_{\ell\geq MCRS} n_{CD\,\ell}}{\sum_{\ell\geq MCRS} n_{CD\,\ell} + n_{CV\,\ell}}$$

$$nRatio = \frac{\sum_{\ell<MCRS} n_{CD\,\ell}}{\sum_{\ell\geq MCRS} n_{CD\,\ell}}$$

where n_{cv} and n_{cd} are the number of fish in the test and standard gear.

The indicator nP_{-} provides an estimate of the fraction of undersize fish retained (< MCRS), thus providing information on the size selectivity of a given gear towards the small fish of a given population. The value of nP_{-} should therefore be as low as possible, and is expected to become lower in response to a successful implementation of the alternatives.

Similarly, indicator *nP*+ provides information on the efficiency of a given gear in selecting commercial sizes (≥ MCRS) when fishing a given population. In such case, provided that the species being analysed is a target species, *nP*+ should be as high as possible (close to 100).

Indicator *nRatio* is the ratio of the number of retained undersized/commercial size individuals. Therefore, when fishing a given population, the size selection properties of a gear are suited to a given MCRS if the *nRatio* is very low, approaching 0. The above indicators are based on specimen number. Indicators based on weight (wP_{-}, *wP+, wRatio*) can also be calculated using the same formulae. To do this, the weight w_l of each individual of size *l* must be estimated according to the general formula $w_l = al^b$.

Except for the absolute measures of 50% retention (L50) and selection range (SR) all of these metrics are population dependent. Hence care must be taken when using and comparing them and consideration must be given to the structure of the populations fished.

This is illustrated in the following example (see figures 4.1.3 and 4.1.4) where the same gear fishes different populations which relate to fishing in different areas and/or time of the year. Despite the fact that the two populations are fished with a gear with the same selectivity, the proportion of fish retained below MCRS (*nP*−) is much greater when the gear fishes the younger (or smaller) population than when the older (or larger) population is fished.

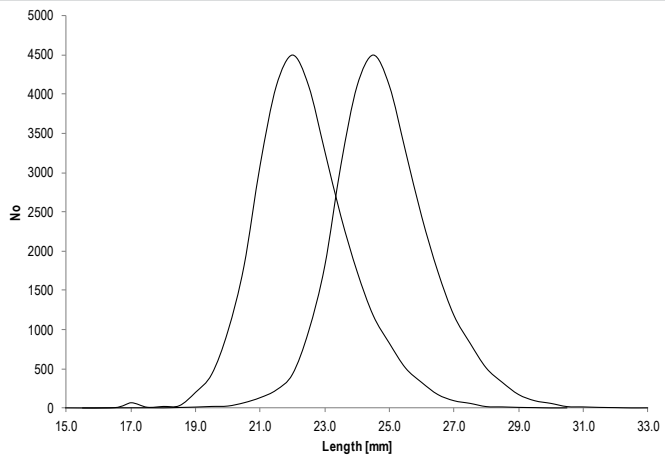

Figure 4.1.3 Curves represent two hypothetical populations of fish entering the gear

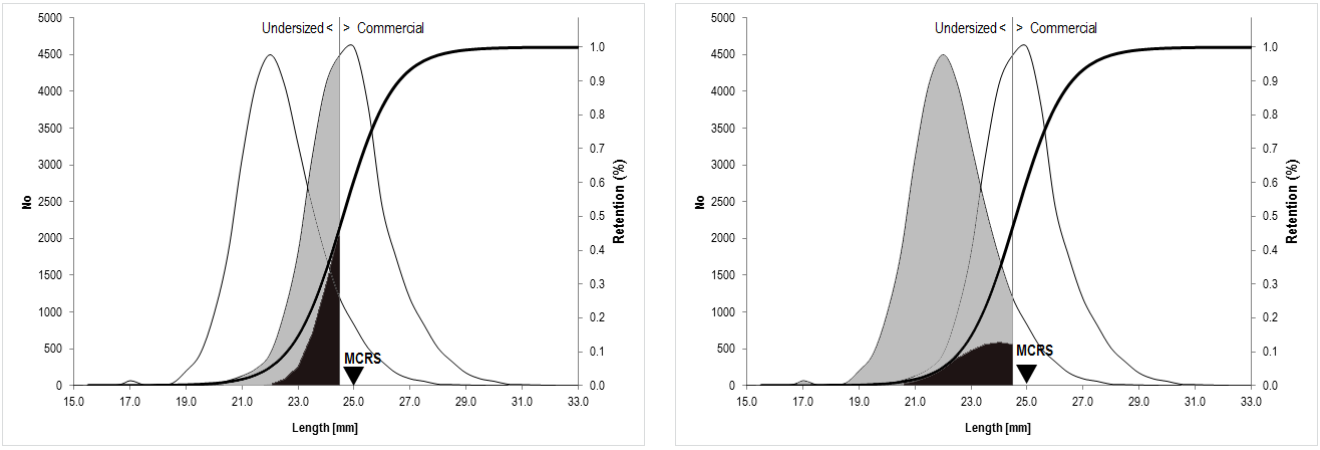

Figure 4.1.4 Two whole hypothetical populations of fish entering the gear; mean size selectivity curve; hypothetical MCRS; in dark-grey the retained fraction of fish below MCRS (*nP*−), the sum of the dark- and light-grey area is the whole fraction of fish below MCRS entering the gear

2nd scenario: different selective gears fishing the same population (i.e. gear changing, introduction of a technical measure)

The second scenario (figure 4.1.5) shows the effect of different gears when fishing the same population. Catch profiles in terms of proportion of fish smaller than MCRS would be different despite the same population.

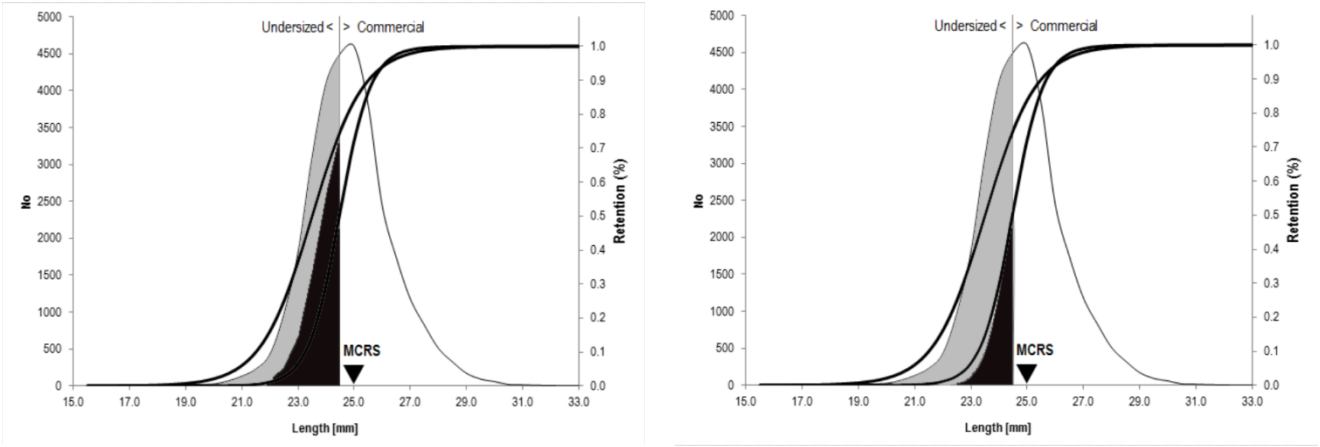

Figure 4.1.5 Two whole hypothetical populations of fish entering the gear; mean size selectivity curve; hypothetical MCRS; in dark-grey the retained fraction of fish below MCRS (*nP*_), the sum of the dark- and light-grey area is the whole fraction of fish below MCRS entering the gear

4.2.Methods to assess the equivalence of new gears

This section describes the methods that could be used by Member States to demonstrate equivalence of alternative gear measures. Depending on the measure, a single method or a combination of methods could be used.

4.2.1. Literature reviews

One of the first ways to investigate the selectivity and catching performance of a proposed gear and the standard gear with which it is being compared is to carry out a literature review of existing gear trials.

This will identify whether the gears in question, variants of them or similar types of gears have already been tested. It will determine what information exists by species and the nature of this information (i.e. is it length/age based, % reduction of catch) and also identify what knowledge gaps exist and what further information is required.

Careful consideration will have to be given as to how representative the data and results are. As the gears and vessels used and the fishing operation may not necessarily fully reflect those being used at present.

4.2.2. Structural models

A number of models have been developed to predict the selectivity of codends based on their design parameters. These models are structural and based on an understanding of the selectivity process and so can be used to extrapolate (within reason) beyond the parameter range with which they have been tested.

The PRESEMO model is an individual-based structural model of the selection process in the codend of a trawl fishing gear that has been developed over the course of the EU funded projects PREMECS and PREMECS II, Herrmann (2005a,b). It simulates different populations of fish entering and escaping from a codend during a tow, taking into account the codend design parameters and the fish escape behaviour. The simulated selection data is then used to obtain estimates of the 50% retention length (l50) and selection range (sr) (Figure 4.2.2.1). A detailed description of this model and its application is given in O'Neill and Herrmann (2007).

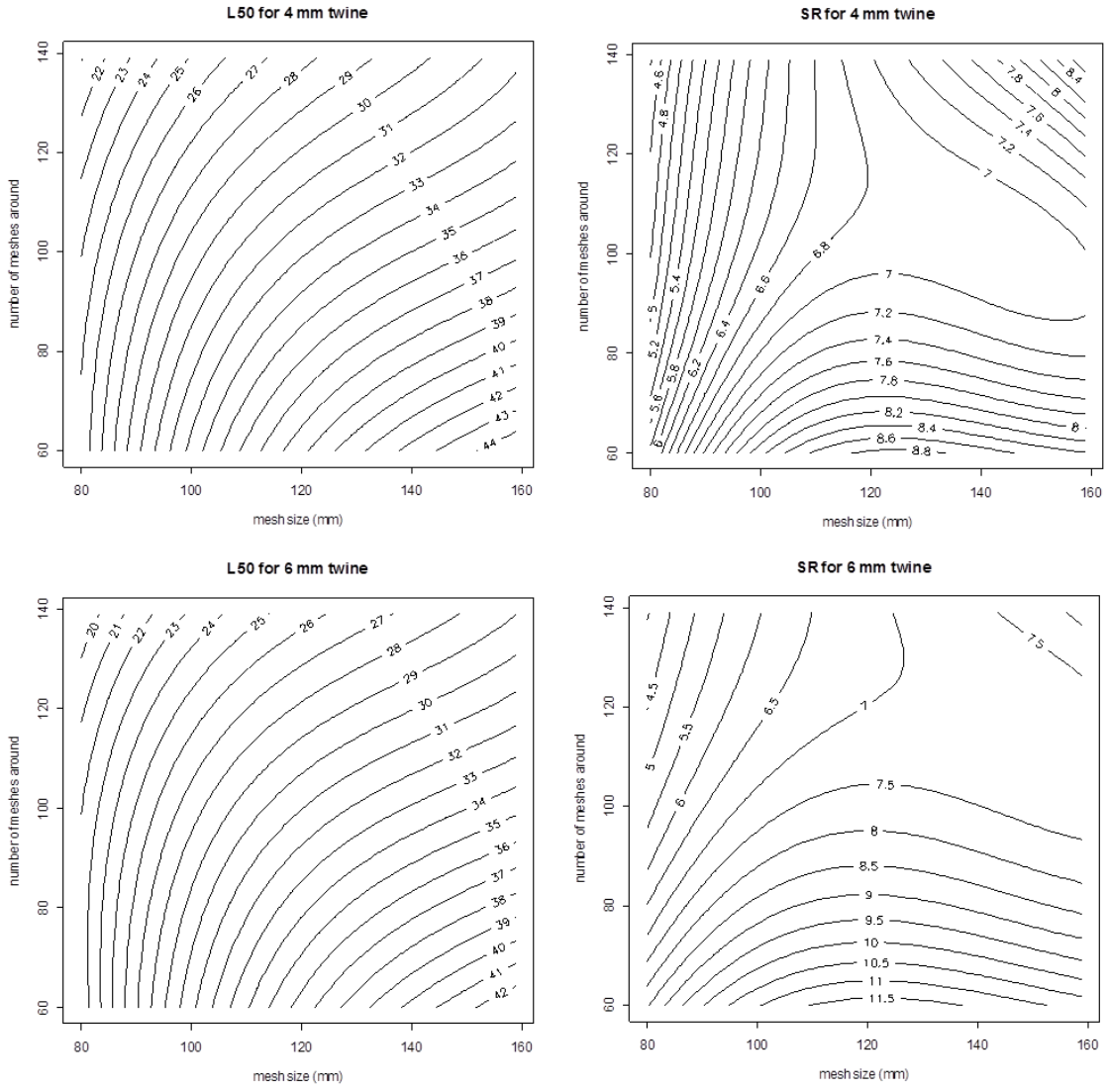

Figure 4.2.2.2 Plots of iso-*l*50 and iso-*sr* curves in terms of the mesh size and the number of meshes around for codends made from (a) 4 and (b) 6mm double braided polyethylene. These curves are predicted using the PRESEMO model of O'Neill and Herrmann (2007)

FISHSELECT is a methodology that measures the morphological parameters that determines the ability of fish to penetrate different mesh types, sizes, and openings. These data are used to carry out morphology-based simulations that can be used to predict the selectivity parameters of codends of different designs and to explain both the within-haul and the between-haul variations reported from sea trials. The most advanced simulations models in FISHSELECT which can simulate the basic size selective properties for nettings with arbitrary mesh shape and size for different fish species, have been used (Herrmann et al., 2009) (Figure 4.2.2.2).

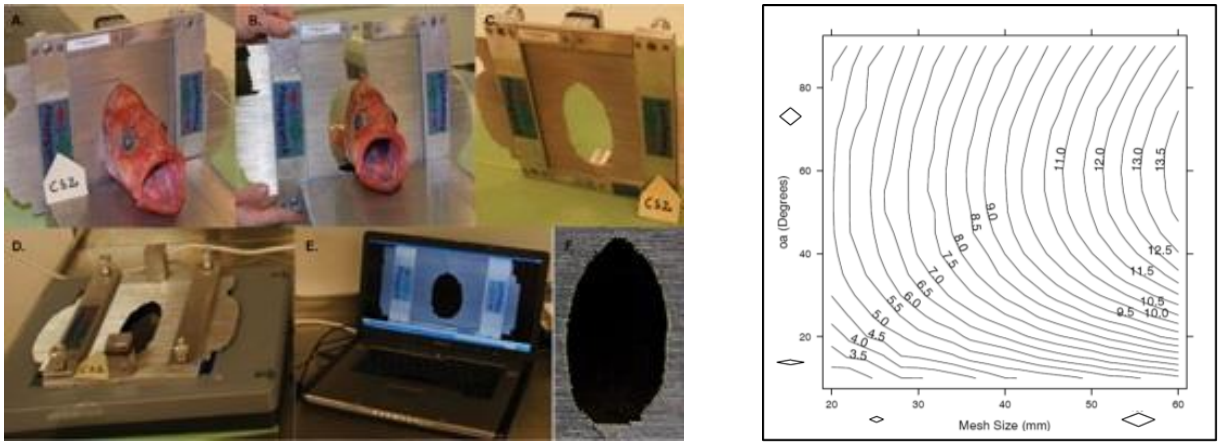

Figure 4.2.2.2 Fish being measured using FISHSELECT morphometer *(left)*; example on Design Guide for diamond meshes for a specific species *(right)*. It shows ISO curves for the size of fish that based on morphology would be able to escape through diamond meshes of different mesh size (*X*-axis) and different opening angle (*Y*-axis) (Herrmann et al., 2009)

4.2.3. Meta-analysis

Individual selection trials typically test only a few gears. Hence, to fully explore the range of gear based options that can be utilised in a fishery, empirical models that predict selection across a wide range of design variables have been developed. These can be constructed in meta-analyses that combine the data from many trials. There are, however, few meta-analyses in the size-selection literature and these usually only consider the effect of codend mesh size. Perez Comas and Pikitch (1994) provided regression estimates of the 50% retention length for 12 gadoid species from 689 experiments of codend mesh sizes. Similarly, Madsen (2007), in a review of the selection of Baltic cod compared the codend mesh size for different codend designs. A more wide-ranging analysis of *Nephrops* (*Nephrops norvegicus*) selection found that codend retention depended on codend mesh size, codend mesh shape (diamond or square) and the presence of a lifting bag (ICES, 2007). More recently Fryer et al (2016) carried out a meta-analysis of the codend and SMP selectivity for haddock and find a dependence on codend mesh size, twine diameter, the number of open meshes around the codend circumference, SMP mesh size and position and season. These models can be very useful and will allow prediction of the effect on selectivity of different design parameters (Figure 4.2.2.3). There is a need, however, to be cautious in their application as they should not be extrapolated from and should only be used within the range of parameters values of the empirical data that they have been constructed with.

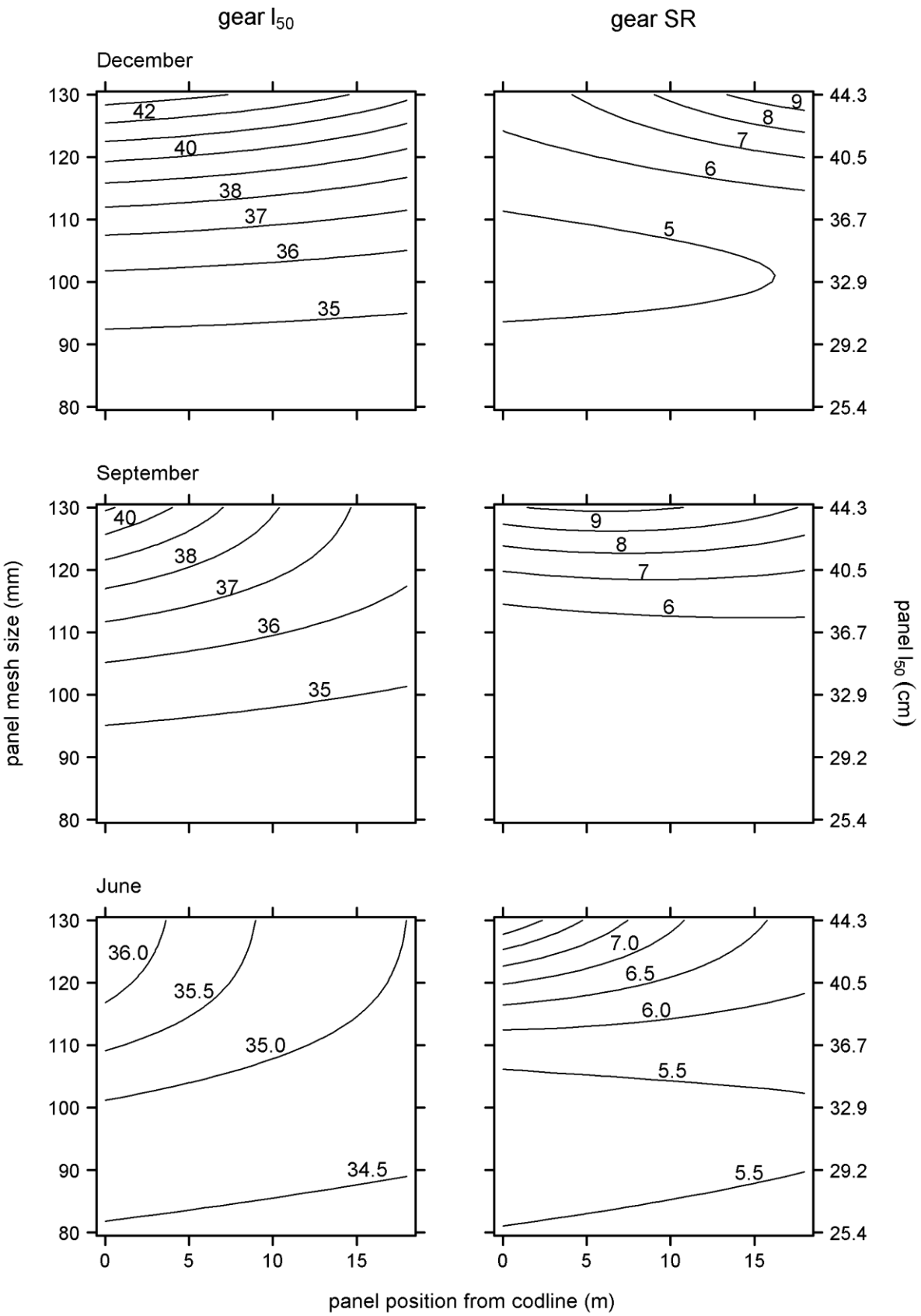

Figure 4.2.2.3 Output from the model of Fryer et al (2016) showing the effect of the square mesh panel mesh size and position on gear L50 (left) and SR (right) for a typical Scottish trawler targeting white fish in December (top), September (middle) and June (bottom)

4.2.4. Selectivity and catch comparison experiments

The two main experimental methods for evaluating and assessing the selective performance of a fishing gear are selectivity experiments and catch comparison trials. The main difference is that in a selectivity experiment, the performance of the gear is assessed in relation to the population of fish on the grounds whereas in catch comparison trials the gear is assessed in relation to the performance of a control or standard gear. The main method used to measure selectivity is the use of covered codends Figure 4.2.4.1 illustrates the methodology used for carrying out a selectivity experiment.

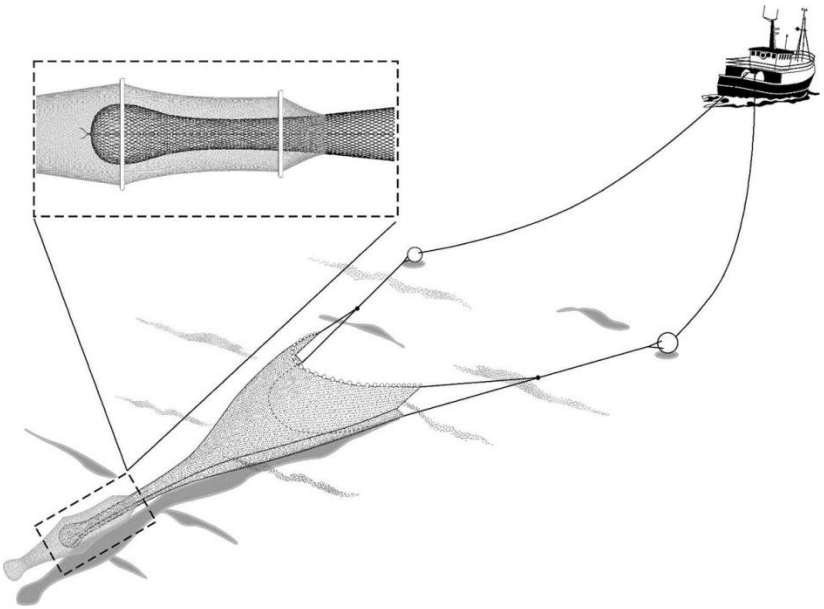

Figure 4.2.4.1 Trawl gear with a covered codend which is often used in experiments to estimate codend selectivity
(Source: Wileman et al., 1996)

In addition selectivity can be measured using a twin-trawl system or through a parallel or alternate haul approaches. These methods are described extensively by Wileman et al. (2016).

The key advantage of a selectivity experiment is that it provides an absolute measure of selectivity that can be considered population independent. There can, however, be issues related to the use of small mesh netting bags or covers that ensure that an accurate sample of the population fished is taken. These bags/covers may compromise how the gear fishes and call into question how representative the gear is of a commercially fished gear.

Catch comparisons trials often better reflect commercial conditions and offer a direct comparison with the standard gear. Depending on the modification /design to be tested, it is often possible to initiate catch comparison trials quickly on fishing vessels and carry them out during normal commercial fishing operations. One drawback is that catch comparison trials only provide a relative comparison of the gears being assessed and one that is population dependent. On the other hand, this type of direct comparison is often more easily understood and more acceptable to the fishing industry as it explicitly identifies the consequences of using the proposed gear. Figure 4.2.2.5 illustrates a typical experimental setup for a catch comparison experiment.

Figure 4.2.2.5 Twin trawl gear where the fishing performance of a test gear is compared with that of a standard or control gear
Source: Crown Copyright

There are many possible experimental approaches such as alternate hauls or parallel hauls, using single, twin or multi-rig gears. The specific approach chosen will usually depend on the fishery, the gear to be tested and what resources are available. For catch comparison trials, twin and multi-rig methods will allow both the standard and test gears to be deployed simultaneously. This will ensure a better assessment of the gears because they will be on the same habitat at the same time of day sampling the same population. In general the best approach is usually the one which reflects the commercial fishing operation as closely as possible.

4.3.Monitoring and continued evaluation

Assuming STECF deliver a positive evaluation of an alternative gear, consideration needs to be given as to how this gear will be evaluated and monitored once introduced as a legal option in the fishery. This evaluation should consider the catch composition, the non-commercial bycatch and the wider ecosystem effects.

Data provided for evaluation of a proposed alternative gear might not be sufficient for STECF to recommend immediate use. In such cases, it could be recommended that further experiments be carried out or that more intensive or other ways to monitor the functionality and selectivity of the new gear are introduced. This may be necessary to evaluate if the alternative gear is in fact equivalent to the standard gear.

Monitoring the effects of the gear over a period of time could be based partly on existing data collected in the Data Collection Framework (DCF), collected during trials for other purposes, or based on targeted initiatives for collecting data on the new gear. The type of monitoring and type of data collected depends on the specific gear and should be decided on a case-to-case basis.

Data collection under the DCF can be via scientific surveys, market sampling and observers on board. The main purpose is to support stock assessment. Direct evaluation of fishing gear is not standard practise under such conditions. Nonetheless these data can be used to provide information on the catch composition of gears but in order to evaluate new, selective, fishing gears, a more detailed and focused data collection might be needed to back this data up. EWG 16-14 has identified a range of methods that could be used to provide data for an ex-post evaluation. These are described in the following sections.

4.3.1. Self-sampling

Self-sampling made by relevant fishermen is a tool that has the advantage that a large amount of data can be collected on many vessels over the different seasons but has the disadvantage that the quality of the data can be low because fishermen are not trained for this task and the trustworthiness of the data can be questionable.

The method has been used for discard sampling, catch reporting and for the collection of length – frequency data for retained and discarded catch (Mangi, Dolder, Catchpole, Rodmell, & de Rozarieux, 2013). As such self-sampling for documentation of effort of a new gear or comparison of a new and a standard gear seems a relevant option.

A number of concerns regarding self-sampling have been raised - both the fishermen's enthusiasm and willingness to participate and continue in self-sampling and the risk of bias or falsification of data collected.

The enthusiasm for self-sampling and willingness to participate to a high degree is dependent on the level of trust and respect established with the fishermen (Dörner et al., 2014). This problem is expected to be less relevant in a case, where the opportunity to use/continue use of a new gear that has been developed or promoted by a certain part of the industry will be a strong incentive to participate in a self-sampling programme. Nevertheless there can be divergent interests and incentives for use of the gear within a group of fishermen, as well as unwillingness to continue efforts to document the functionality of the gear if the concerns are not clearly communicated and accepted. Therefore self-sampling data needs to be cross-referenced against logbook and other forms of data (Mangi et al., 2013).

An issue also noted in Mangi et al. (2013) is the concern among fishermen regarding the use of the data. The direct use of the self-sampled data to demonstrate equivalence of a the new gear largely negates this issue, though ownership of data and possible other uses of the collected data should be considered.

The risk of bias or falsification in self-sampling programmes should also be considered in setting up a tailor made method to assess the quality of data for the specific self-sampling programme. Fishermen should be trained in self-sampling techniques according to protocols developed by research or in cooperation ensuring reduced risk of bias, though it should also be kept simple (Lordan, Cuaig, Graham, & Rihan, 2011). Generally fishermen are more accepting towards assessing volume of catches than length measuring (Mangi et al., 2013). Reduction of risk of falsification could be done by supplementing data collection by observers and statistical methods for checking data quality in the process of calculation.

In conclusion, self-sampling can be a representative method to provide a large amount of data taking into account that training of fishermen is provided, and there is cross-checks on the quality and trustworthiness of data collected.

4.3.2. Observer programmes

There are already observer programmes under the DCF. The data collected under the DCF would provide a ready way means of monitoring the specific gear. However, in many cases a specific observer program will probably be necessary for monitoring and documenting alternative gears.

Observer data usually are of high quality, are trustworthy and follow methods that are well tested through practise for many years. The disadvantages are that they are not well suited to small vessels, can be expensive to run and can often have only low coverage of a specific fishery. On their own they may not provide the relevant data that would suffice to demonstrate equivalence of alternative gears. They will not always provide data that are representative for the whole fleet using the alternative gear.

In conclusion, observer programs provide good quality data and can form the basis for the assessment of alternative gears but they should be completed with other methods that have a larger coverage.

4.3.3. Remote Electronic Monitoring (REM)

REM is a combination of different electronic based methods for monitoring of fishing operations. It has been in use experimentally for some years, but is still under development. The method has developed as been used principally as a means to control discarding practices in combination with other supporting documentation (e.g. log-books, self-sampling etc.) In cases, where catches are already sorted by species, the method can provide good data on species and size composition of the catch although to monitor such information is extremely labour intensive. The technology is expected to further develop in direction of automatized analysis of camera data and would in that case allow quicker and more accurate species and size data for all parts in the catch.

The main disadvantages of REM are that in certain fisheries, especially with unsorted catches, the method has not evolved enough to be able to provide good data. There is also very little willingness from industry to allow camera's on board on a widespread basis as it is seen as intrusive while it can be difficult to use on small vessels. Cost of analysing footage and data as well as maintenance issues have also been noted.

This method, for the time being, is better suited for purposes of control and enforcement rather than for purely data collection. However, taking the limitations stated into account, this method has the potential to provide additional information on a long-term basis. Future development may allow a wider application including for the use of demonstrating equivalence.

4.3.4. Last haul analysis

Article 104 of the Control Implementing Regulation (Regulation (EU) 404/2011)) specifies provisions for the monitoring of catches during fishing gear inspection. The European Fisheries Control Agency (EFCA) in cooperation with Member States has established Joint Deployment Plans (JDPs) separately for the Baltic Sea, North Sea, Western Waters and Mediterranean regions. JDPs are coordinated by EFCA. One of the functions of the JDP s is collecting catch-composition data through the so called "last haul analysis".

The last haul analysis is carried out by the inspection services after boarding a fishing vessel. In principle this provides similar information as a scientific observer collects but is focused on commercial fish species as well as catch fractions related to the landing obligation. However, it is limited to data from one specific haul which may or may not be representative of the fishing trip and is principally a source of data that can be cross-reference against other data sources, in particular observer, logbook and self-sampling data.

One drawback with the last haul analysis is in the use of the data due to confidentiality of professional and commercial secrecy (article 113 of the Control Regulation (EC) No 1224/2009. Therefore if it were to be used as a further data source for the monitoring of new gears, these issues would need to be resolved.

4.3.5. Modelling

Predictive structural modelling techniques as described in section 4.2.2 may also provide information for monitoring and continued evaluation of fishing gears. Such models can predict the effect on selectivity of certain changes in the fishing gear and in combination with physical observation could be used.

4.3.6. Pros and cons of the different evaluation techniques

Table 4.3.6.1 summarises the main pros and cons of the different monitoring and continued evaluation techniques available.

Table 4.3.6.1 A summary of the main pros and cons of the different monitoring and continued evaluation techniques available

Description	Data	Pros	Cons	Useful for ex-post evaluation of indicators of equivalence
Self-sampling documentation of new and possibly standard/baseline gear. Fishers to sample data during ordinary fisheries activities, following protocols set up by research or research and fishers in cooperation. Data are provided for science for validation and calculation.	Depend on the specific protocol according to the need for comparison of standard and new gear, or absolute effects of the new gear. -Catch composition, volume and length frequency of all catch fractions (including discards and unwanted catches) -Length-weight data from all/part of the catch	Self-sampling can provide a large amount of data collected on many vessels over different seasons. In case of fisher (co-) developed gear willingness to participate with the incentive of using the gear is expected. Industry support and ownership of data and results.	Depends on fishers' willingness to participate (see pros). Clear (partly tailor made) protocols is needed to avoid bias – but simple to enable fishers to follow Training of fishers in methods might be needed. Data need to be verified by statistical methods and observer data collection.	*Sex/size composition:* SEX: NO SIZE: YES, but limited of space and time consuming *Total fishing mortality:* NO *Species composition:* YES *Habitat effects:* NO
Observer programmes Observers collecting data according to the specific need. -part of existing observer program(s) -directed observer program	Depend on the specific protocol: DCF data: biological data, by catch fractions; data to assess the impact of fisheries on the marine ecosystem Directed programs could focus on the relevant data (catch composition/length composition etc.). Representative data collection could be ensured	By using data from existing observer programs the data collection can take place without extra cost. Calculation/documentation would though be directed towards the specific gear monitoring. Biasing the observations towards higher coverage in relevant fleet/water could be considered Could be supplementing other sampling methods	The coverage of the specific gear/fleet might be too little or not representative by using existing DCF/other observation data. Establishing a specific observation program is costly. For both some vessels might not be covered due to size (safety) or reluctance to	*Sex/size composition:* YES *Total fishing mortality:* NO *Species composition:* YES *Habitat effects:* NO – (maybe indications)

			take aboard observers	
Remote Electronic Monitoring Various electronic devices for monitoring activities at the vessel – sensors at trawl winches, VMS, cameras monitoring fish haul and sorting etc.	The electronic data collected covers: -GPS logging (place and speed – fishing/steaming) -register of use of trawl (or other active fishing equipment) -camera monitoring of handling of catch (sorting, discarding etc.) The technology has mainly been used for documentation of discard registration and control. Documentation of other data reported	Relative cheap operation costs for electronic data collection and storage. Fishers with sorting and conveyor belts only need to slightly change practice to ensure the cameras can monitor the belts. High reliability of camera surveillance – fisher reports The technology will in the future be able to automatic register and measure species and size – e.g. register, not only document other data.	Relative costly investment in equipment. Manual monitoring of camera and other data is costly (only random check). Might change by automation. Resistance against surveillance from fishers – need strong incentives to be accepted.	*Sex/size composition:* Sex: NO Size: Yes: In some situations/with new technology *Total fishing mortality:* NO *Species composition:* YES *Habitat effects:* NO
Last haul analysis Carried out on-board fishing vessels inspection of last haul of fishing gear	Catch composition, volume of catch fractions Ratio: MCRS weight /total weight per species	No additional cost; trends over time and by areas; indicator on gears selectivity;	Low cover and focuses on commercial species; limited by JDP framework; Restricted availability of the data use for non-control purposes (article 113 of Reg. 1224/2009)	*Sex/size composition:* SEX: NO SIZE: YES, but limited *Total fishing mortality:* NO *Species composition:* YES *Habitat effects:* NO
Modelling Simulations of new gears. Input of gear design and species with output of gear selection.	Depends on the model. Gear specific characteristics and species	Quick and cheap results	Limited no of selective devices available. Not available for all fish species. Not valid for all species behavior. Model validation	Depending on model: *Sex/size composition:* YES *Total fishing mortality:* YES *Species composition:* YES *Habitat*

			may be necessary.	*effects:* YES

4.4.Case Studies

The group considered different case studies:

1. Case study 1 – describes previous attempts to assess equivalence that arose from the cod recovery plan (Regulation (EC) 1342/2008)
2. Case study 2 – describes a proposed alternative gear and how STECF might reasonably respond following an evaluation of the supporting information.
3. Case study 3 – describes proposed gears that are of a complex design and highlights how these could be enacted into law following evaluation.

Case Study 1

Some lessons from previous experiences of gear innovation are important to bear in mind in the future technical framework. As reported from EWG 13-04 (STECF, 2013), incentives in the cod recovery plan created positive examples (e.g. the Scottish conservation credit scheme). Under this scheme there have been numerous examples of technical innovations as fishermen have strived to develop innovative gears to reduce cod catches. Also in other Member States like Ireland, Denmark and Sweden, articles 11 and 13 of the cod plan led to significant increase in innovation and uptake of more selective fishing gears.

In the Scottish conservation credit scheme, the metric used to measure equivalence was trends in cod CPUE with new gears. CPUE was based on observer trips. Alternative gears in both the whitefish (TR1) and *Nephrops* (TR2) fleet segments were considered. On the basis of the analysis carried out a range of gear options were selected and were then detailed in a national conservation plan.

To implement these measures there was a need to define the specifications of the various gear options. The intention from the start was to try and keep these specifications as simple as possible yet provide enough detail so that the gears could be rigged and fished as intended. The design features of the TR1 gears (the Orkney/Shetland cod avoidance trawl) were very straightforward with simple definition, which essentially specified the mesh size and dimensions of the forward panels. These definitions proved adequate in describing the gear for both operational and enforcement purposes, which may be attributable to the simplicity of the design modification and the robustness of the measure (insofar as small 'tweaking' is unlikely to significantly alter the selection characteristics).

For the TR2 'highly selective gears' (FCAP) design features were more complicated. For these gears there was a greater need for detail due to the design changes being more innovative and the designs being less robust (small deviations from the design could lead to large changes of selectivity). The definitions of the TR2 gears also underwent a certain number of iterations as clarification was sought from either the fishing industry or the enforcement agency with regard to issues such as weak links, twine thickness, flotation, positioning of escape holes etc. Although this iterative process had the potential to be onerous and time consuming, in this particular case it was not. Once the modified definition was agreed by the fishing industry and Marine Scotland, all that was required was an update and a reissue of the scheme rules. While the national cod management scheme created some degree of administrative and scientific burden, the process of introducing and adapting the gears permissible and the incentive structure used for the TR1 gears, was relatively straightforward and critically there was no complex legislative process.

It could be envisaged that some of the approach used in the Scottish Conservation credit scheme could be useful in developing guidance for assessing alternative gears that may be proposed by Member States regionally, particularly in relation to the evidence and metrics.

Case Study 2

The second example was a case where the alternative gear proposed involved reducing mesh size but modifying the codend construction by increasing the codend circumference and length of a baseline gear. The proposal to adopt this gear was supported by results from a series of scientific experiments and the results of the supporting study showed equivalent (or even improved) size selectivity to the baseline codend with the modified codend arrangement. The results of the experiments showed the alternative gear caught less small fish below MCRS.

On assessment it was found that while the results from the experiments were robust they were counter intuitive to what would be expected (i.e. that reducing the mesh size would decrease selectivity). In this case there are several possible explanations to the observed discrepancy. One is that the variability between individual experimental results is often significant in selectivity studies (including catch comparison experiments) and that the new study just presented an unexpected result that, however, still remained within normal between-study variation. Another possible explanation is that some unknown (uncontrolled) factor has influenced the outcome (e.g. different population size structure, other trawl design differences or changed fish condition).

The group elaborated on a possible advice that STECF could give in such a situation and identified three options.

1. The request could simply be endorsed by STECF based on the seemingly sound scientific information provided in the new study.
2. STECF could advise not to permit derogations on the ground that the results (i.e. equivalence) of the new scientific study is unlikely to be representative in light of all previous scientific knowledge.
3. STECF advise that if a derogation were to be granted, it should be conditional on further experimentation and monitoring through increased observer coverage.

Case Study 3

The third case considered how to adopt complex gears as alternatives to the baselines. It considered two real and potential future examples of complex gears as shown in figure 3.3.1. The gears have been developed by the Swedish industry recently in order to better adapt to the landing obligation. The upper drawing shows a further developed variant (EXP) of the standard Swedish grid used in the *Nephrops* fishery in the Skagerrak. The intention with the new variant is to reduce unwanted catches of all catch components apart from large *Nephrops*.

The lower drawing below shows a whitefish trawl (TR1) with a 120mm codend that has been modified in order to be able to separate witch flounder in a lower codend and large roundfish in a second upper codend (EXP). The idea is that the mesh size in the upper codend can be adjusted depending of roundfish quota availability. The upper codend can even be demounted if quotas are exhausted.

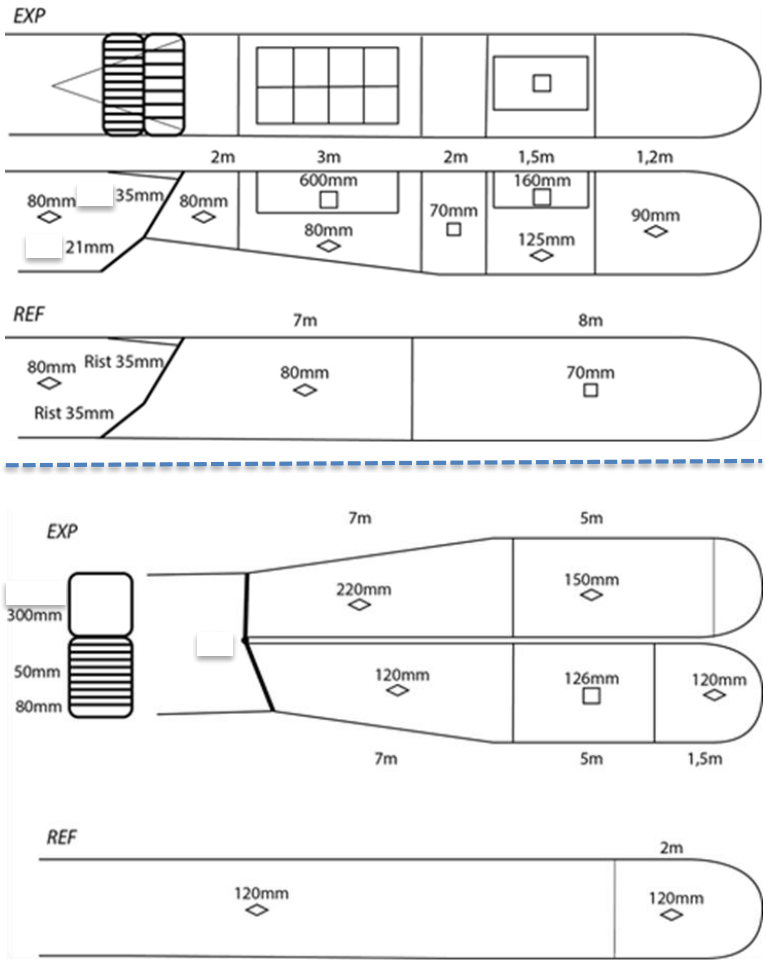

Figure 3.3.1 Examples of complex experimental gears

In this example based on available experimental data which showed both gears to be more selective than the baseline gear the advice would probably be positive. However, this would create a dilemma for administrators as to define these gears in totality would be very complex. Without pinpointing exactly where these two example gears violate current technical regulations, not all constructional elements would be necessary to specify in future regulations. In this case a pragmatic approach would be needed to the legislation to allow the use of such gears. For the new *Nephrops* trawl design only the minimum mesh sizes of square mesh (>70 mm) or diamond mesh (>90 mm) need to be defined. For the TR1 example only a provision for using two codends (>120 mm) is needed. All other design changes only increase selectivity and can be left open for individual flexibility needs. In this regard the use certification/authorisations attached to the use of such gears could be considered. This would avoid the need for detailed definitions in legislation.

5. SCENARIO 2 – NON-GEAR BASED MEASURES

Non-gear-based measures include:

- spatial and temporal closures;
- real-time closures;
- fully documented fishery approaches;
- reductions in fishing effort; and
- minimum conservation reference sizes.

EWG 16-14 considers that demonstrating equivalence for these types of non-gear based measures is much more difficult than for selective gears. In addition the assessment of these types of measures is complex and requires significant amounts of data to allow proper evaluation and continued monitoring. This is further exacerbated by the fact that in some cases the measures will be proposed in combination with other measures

In this section the evaluation methodology and metrics that STECF could use to evaluate equivalence of these types of measures as alternatives to baseline gears are described. This is indicative rather than definitive and EWG 16-14 highlights that further work is needed to refine the methodologies and metrics used. Case studies, where available, are provided to illustrate how these types of measures have been used in the past as alternative management measures, the impacts that have resulted and also the evaluations carried out to assess effectiveness.

5.1. Spatial and temporal closures

5.1.1. Description

Spatial and temporal closures may be used as an alternative measure to the baseline as a means of reducing fishing pressure in a localized area. Several types of areas, each one with specific characteristics could be closed, including nursery or spawning areas, areas of aggregation of target and/or non-target species or areas to protect specific habitats. The potential mitigation effect of the closure will depend on the objective, specifications and duration of the area closed to fishing. In theory, such tools should be more efficient for species for which large aggregations take place during its life cycle, for instance in relation to juvenile feeding grounds or reproduction. Closures can be permanent, (e.g. on a nursery area which are present the whole year to protect juveniles), temporary, (e.g. during the spawning season when mature fish aggregate) or real-time (dealt with in section 5.2) when "sporadic" and randomly distributed high densities of fish are observed. It must be stressed that implementation will be case specific as its efficiency will depend on the biological characteristics of the species involved and of the way the fishery operates.

In terms of the equivalence criteria – exploitation pattern, exploitation rate, species composition and habitat – EWG 16-14 considers the following to be important:

<u>Exploitation pattern</u>

Closing an area with a high concentration of a specific fish of a specific size-range (juveniles or spawners) may offset the increase in fishing mortality on that size-range associated with the baseline measure. The closure can be better directed towards specific size ranges if, for a given species, ontogenetic changes in distribution occur (i.e. specific nursery or spawning area).

<u>Exploitation rate</u>

For fisheries for which current management is based on a TAC and there is full compliance, there may be, in principle, no need for mitigating tools to guarantee equivalence on total fishing mortality, as it is expected that the total amount of catch will be capped by the allocated TAC. However, using a more "effective" gear may increase the risk of TAC overshoot (and therefore increased overall fishing mortality) and may lead to a premature closure of a fishery. In that

case, closing an area may allow the fishing operation to be carried out over a longer period in a given year.

In the case of the Mediterranean where management is currently not based on TACs and the use of a new gear could potentially lead to an increase in total catch (and associated F), area closures could be used to mitigate against the increase in total fishing mortality. For this closure to work there is a need to ensure that the effort redistribution (if any) does not lead to an increase in F in the fished area equivalent to the F reduction associated with the closure.

Species composition

It may be that the introduction of a new gear leads to changes in the catch profiles of the fleet using that gear, (i.e. that the relative proportion of species in the catch (and associated fishing mortalities) will change although these changes may also be the consequence of variations in population associated with high recruitment for instance). It may then be possible to compensate for the increase in F for a given non-target species by closing an area in which that species is particularly abundant and/or at a particular time. It must be noted that if several species are impacted by the new gear, the use of such a mitigation approach to reconcile the new catch profile with the one previously observed may prove highly complex.

Habitats

In extreme cases the introduction of a new gear may result in increased impacts on benthic communities or impacts on benthic communities not previously impacted. In this case spatial closures could also be used to mitigate the damaging effect of a new gear on sensitive habitats. The closure could be used to reduce these impacts but would obviously only work if the characteristics of the closed area are similar to the one impacted by the new gear.

5.1.2. Measuring equivalence

Spatial closures are suited to addressing issues associated with all of the equivalences in Table 3.2.1 with temporal closures able to address all of the equivalences except for the criteria relating to habitat protection. In relation to size composition/exploitation pattern, total mortality/exploitation rate, species composition, broadly similar methodologies and data are required to establish and evaluate them regardless of they are spatial or temporal closures. Measuring equivalence in relation to habitat impacts will require additional information.

Analysis and evaluation

For the equivalence criteria associated with exploitation pattern, exploitation rate and species composition the analysis and evaluation methodologies that could be used are similar. These include the following:

a. Simulations or Management Strategy Evaluations (MSEs) of the impact on size composition, total F and species composition of introducing the new technical measure and closing a specific area (a priori).
b. For stocks with an assessment, examination of resulting exploitation pattern by comparing relative fishing mortality at age/size before and after the implementation of the new gear. For other stocks, examination of changes in length/age distribution of catch or of average length of catches. (ex-post).
c. In the case of analyzing and evaluating the impacts on exploitation rates, it would be important to have information on the risk of non-compliance and the potential changes in fishing mortality level
d. Assessment of the consistency of the new technical measure with (ecosystem) management objectives
e. Estimates of aggregate effect of the new technical measure on habitats
f. Representative surveys of aggregation grounds

Data Requirements

Several sources of information and data are needed to demonstrate equivalence regarding the different criteria. These include:

a. Information on the location and relative abundance of the fish size-specific ranges and species impacted by the technical measure in the closed area (obtained from a survey for instance). This information will need to be collected on a regular basis so that the validity of the closed area can be evaluated overtime.

b. Information on the recent distribution of effort to avoid closing an area where there is no fishing.

c. Estimation of the potential quantity of fish at size protected in the closed area and of the increase in the quantity of fish caught in the fished area following the introduction of the new technical measure.

d. Information on the location, duration and relative importance of persistent aggregations in the case of temporal closures in particular.

e. Estimation of the potential quantity of fish spared in the closed area and of the increase in the quantity of fish caught in the fished area following the introduction of the new technical measure

f. In the case of habitats, mapping of the habitats impacted, recovery time in relation to disturbance as well as information on characteristics of the new gears.

Table 5.1.2.1 Equivalence issues and corresponding data needs

Equivalence Issue	Data
Exploitation pattern (avoid juveniles/spawners)	Information on the location, duration and relative importance of persistent nursery/spawning/aggregarion areas. Representative surveys of such areas. Information on distribution of fishing effort Information from surveys and catches on distribution and timing of recruitment/spawning. (temporal closures)
Exploitation rate	Information from surveys and catch on the location, duration and relative importance of persistent nursery/spawning/aggregarion areas. Representative surveys of such areas. Information on distribution of fishing effort Compliance rate Catchability change and estimate of expected change.
Species composition	Information from surveys and catches on the location, duration and relative importance of persistent nursery/spawning/aggregarion areas. Representative surveys of such areas. Information on distribution of fishing effort
Habitats	Maps of habitat, Recovery time of habitat in relation to disturbance, information on gear characteristics, Information on distribution of effort

5.1.3. Case Studies

Several examples of spatial measures implemented in the Mediterranean arise demonstrate the use of spatial closures as alternative measures. These arise from the multiannual management pan (MAP) for demersal fisheries in the Strait of Sicily developed by GFCM; spatial changes in fishing effort allocation which have taken place in the Ligurian and North Tyrrhenian Sea; as well as general measures included under the Mediterranean Regulation (Regulation (EC) 1967/2006). Two other case studies relating to temporal cases are also reported. These relate to the temporal closure of the Jabuka/Pomo Pit in the central Adriatic and the use of seasonal fishing bans by Greece and Italy in certain areas of the Mediterranean.

Case Study 1

Multiannual management plan for demersal fisheries in the Sicily Channel

In 2016, a GFCM recommendation established a multiannual management plan for the fisheries targeting European hake or deep-water rose shrimp in the GSAs 12, 13, 14, 15 and 16 (Sicily Channel). This recommendation applied to bottom trawls above 10 meters length overall targeting such species, (i.e. when these species represent at least 25 percent of the catch in live weight or value). The technical measures included under the plan were as follows:

1. Fisheries Restricted Areas (FRAs) established for the conservation and management of the target species in three areas of the Strait of Sicily. In these areas no fishing activity with bottom trawlers is allowed.
2. In order to avoid accidental access to the FRAs, buffer areas have been set up around the outer perimeter of the FRAs. These buffer areas extend one nautical mile beyond the established FRAs.
3. Any fishing activity with bottom trawlers in the buffer areas is monitored through VMS. Those vessels not equipped with VMS transponders and aiming to fish in the buffer areas must be equipped with any other system of geo-localization, which allow the relevant control authorities to track their activities.
4. The SAC (Scientific Advisory Committee) of GFCM identified additional nursery areas of European hake in the Sicily Channel, in particular in GSAs 12, 13, and 14.
5. Fishing activities with bottom trawlers are prohibited between the coast and the 200 meter depth isobath of GSA 14 (providing protection for the Gulf of Gabès). This closure applies from 1 July until 31 September.

This set of technical measures was devised to improve the current exploitation status of the two target species. In particular, the high ratio of F/F_{MSY} of hake requires drastic effort reduction, with significant consequences for the sector in the region. Instead of enforcing drastic effort reductions as would be required to manage the hake stock, the objective of the MAP is to reduce effort by adjusting the F/F_{MSY} ratio of deep-water rose shrimp, and to implement a series of closures to protect mainly hake juveniles. The combination of measures is designed to deliver the objectives of the multiannual plan instead of stringent effort reductions.

Case Study 2

Spatial changes in fishing effort allocation in the Ligurian and North Tyrrhenian Sea

Nursery areas in the Ligurian and North Tyrrhenian Sea (GSA 9) are among the most dense concentrations of age 0 hake recorded in the Mediterranean Sea (figure 5.1.3.1.). They are localised between 100 and 200m depth, and demonstrate a strong annual persistence in location and size. Age 0 individuals can be found in these nursery areas due to the optimal environmental conditions during the whole year and in particular abundant supplies of food. As individuals approach 1 years of age, they move towards shallower waters.

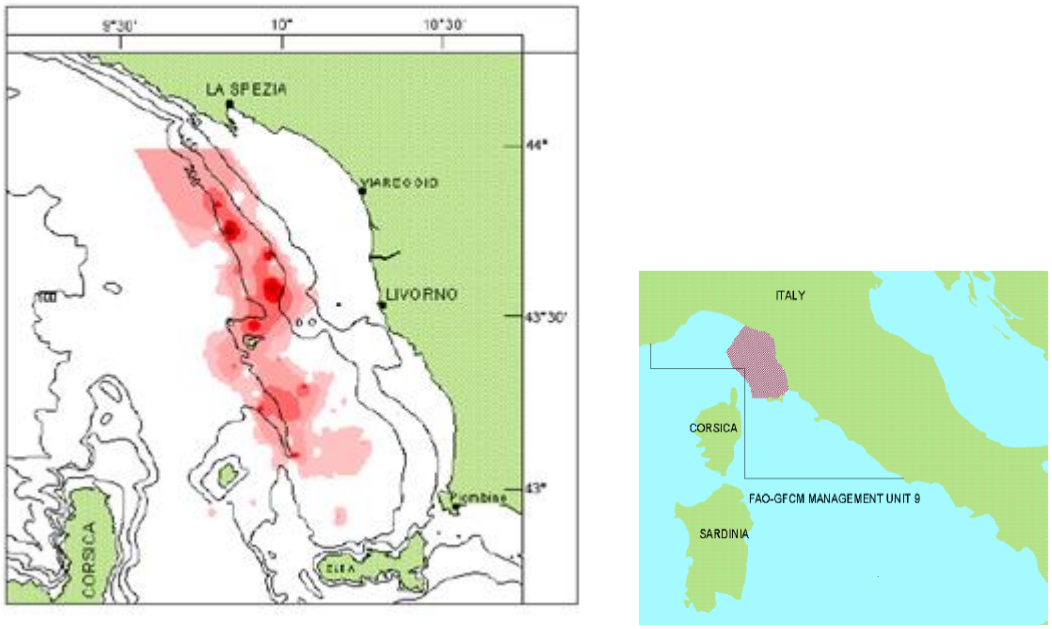

Figure 5.1.3.1 Distribution of nursery areas in the operational limits of the Viareggio fleet in Ligurian and North Tyrrhenian Sea (GSA9)

These nursery grounds were historically exploited by Viareggio bottom trawlers as there was a high market request for juvenile hakeeven though a minimum landing size of 20cm was in place. The minimum size was not enforced and and illegal landings persisted. Operations were performed using traditional Italian bottom trawl gears characterised by a very small vertical opening and small mesh codend. Hake catch rates in these areas were high and market prices of catches were also high. Catches of other commercially important species in these nursery grounds were insignificant; but catches of juvenile hake alone were sufficient to make the fishery profitable.

After a major push to enforce the minimum size in the late 1990s, fishermen were forced to discard the bulk of their undersized catches of hake at sea. As a result fishing in the nursery areas became uneconomic, and fishermen eventually avoided the hake nursery areas completely. In this case the effect of such a "voluntary" change in behaviour is equivalent to the results that could have obtained through the implementation of a spatial closure to protect the nursery area.

Figure 5.1.3.2, shows the effort distribution of the Viareggio bottom trawl fleet in two different periods, before and after the enforcement of the landing controls. It is noticeable that the area where age-0 hake individuals are concentrated was abandoned by the trawl-fleet. Part of the fleet moved to shallower waters targeting mixed demersal species that included hake but where catch rates were much lower. The hake caught in these areas were larger, mainly of ages 1 and 2. Some other vessels moved to deeper waters mainly targeting *Nephrops norvegicus*. Such a spatial shift in effort allocation resulted in a different size composition of the hake catch and landings and an overall reduction of the removals of the smallest individuals of the species as shown in Figure 5.1.3.3. The catch profiles changed significantly over this period ass shown in figure 5.1.4.4.

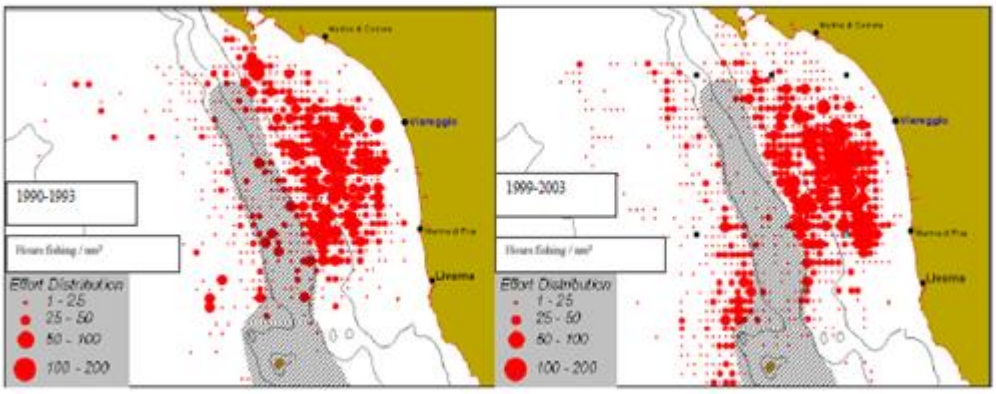

Figure 5.1.3.2 Observed changes in the spatial distribution of fishing effort of the Viareggio bottom trawl fishery. Grey shadingrepresents the boundaries of nursery areas

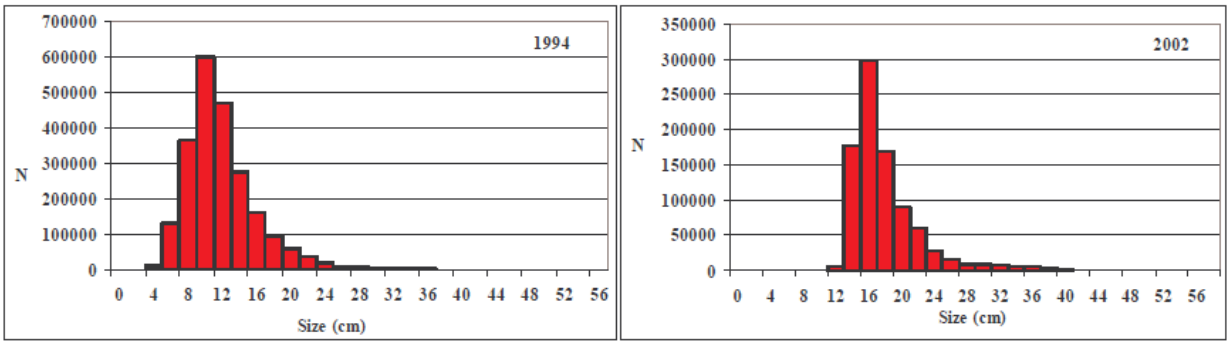

Figure 5.1.3.3 Size structure of the catch of bottom trawlers in 1994 and 2002

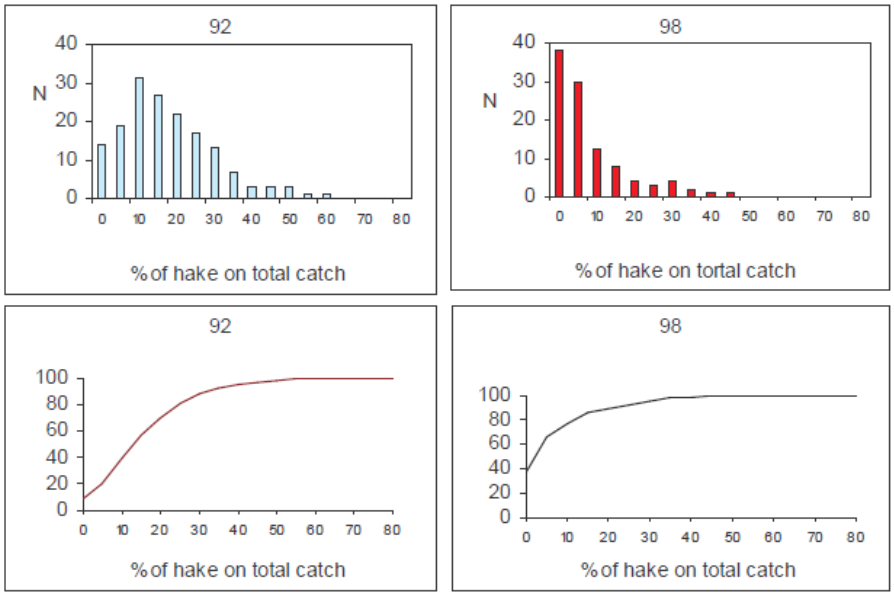

Figure 5.1.3.4 Changes in the frequency distribution of the proportion represented by European hake in the total landings for years 1992 and in 1998 (top) and cummulated landings (bottom)

Case Study 3

Spatial measures included in the Mediterranean Regulation (Regulation (EC) 1967/2006)

It is well known that many commercially exploited resources such as *Mullus barbatus* and *Pagellus erythrinus* populate the fishing grounds along the Mediterranean coasts in areas very close to the coast. These inshore areas are often characterised by having areas of sensitive habitats (i.e. Posidonia beds) that need to be protected due to their important ecological role as a refuge for young fish.

The Mediterranean Regulation prohibits fishing operations for trawlers within the 3 nautical miles or where the shelf drops off quickly, trawling is only allowed at depths greater than 50m. Such a prohibition applies year round.

Coastal protection measures are considered useful, even though they apply differently for each stock. Their efficacy is dependent on the time between settlements in the area until the fish migrate out of the area. For most species, after a period of inhabiting areas close to the shore, the young fish slowly move towards deeper waters. The delay in fishing on juvenile population as through the closure of areas close to shore leads to an increase in the size of first capture. As individuals are still of a small size immediately after leaving inshore areas, there are proposals to increase the areas where trawling is prohibited in order to bring about improvements in exploitation pattern aimed at increasing the size of first capture to MCRS.

Case Study 4

Temporal closure of the Jabuka/Pomo Pit

In Central Adriatic, the Jabuka/Pomo Pit (GSA 17) is a sensitive habitat and nursery ground for European hake, with a high concentration of small *Nephrops*. The area has been closed for trawling based on a bilateral agreement between Italy and Croatia from 26th of July 2015 to 16th of October 2016. The main issue that arose from this closure was the increase of fishing activities conducted with static gears (mainly gillnets and longlines) targeting large hake and large pelagic species. Moreover, some trawlers that were usually operating in the area started using longlines in the area. The conflicts originated by this closure are probably one of the reasons why the closure stopped, evidencing the need of coupling area closure measures with more general management measures which prevent switching from one gear to another, or to prevent the increase of other activities (set gears in this case) in the same area.

Case Study 5

Seasonal fishing ban

In certain areas of the Mediterranean, (i.e. in Greece and in Italy), seasonal fishing bans for trawlers have been implemented, aimed at a general reduction of the fishing pressure, avoiding conflicts with small scale fisheries, and especially protecting resources in particular periods of the year where juveniles are more vulnerable to the gears in use. Many times, in these periods juveniles are concentrated and catch rates, and consequently removals, may be too high. With this measure, other than a generalized reduction of overall effort, it is expected to improve the exploitation pattern, as individuals have more time to growth before they recruit to the fishery.

5.2. Real time closures (RTCs)

5.2.1. Description

Real Time Closures (RTCs) offer an alternative approach where the feature giving rise to the deviation from the baseline (e.g. exploitation pattern/size composition, total mortality, or mixed species issues) is variable and unpredictable in time and space. RTCs offer a way of quickly responding to variability in distribution and may therefore more effectively lead to avoidance than closed areas with fixed locations. This approach is potentially useful when dealing with situations

involving aggregations of juvenile fish, spawning fish or unwanted fish (species with low quota, protected species etc.) and where there is a need to control or reduce fishing mortality.

5.2.2. Measuring equivalence

RTCs are particularly suited to addressing issues associated with 3 of the 4 equivalences in Table 3.2.1. In relation to size composition/exploitation pattern, total mortality/exploitation rate and species composition issues, broadly similar methods are required to establish and evaluate an RTC scheme. The only substantive difference relates to the biological features that need to be quantified.

Analysis and evaluation

An RTC proposal would need to be able to demonstrate that the establishment of a certain number of RTCs of particular size were able to provide the required 'correction' to ensure equivalence to the baseline or a desired management objective and that the scheme would not cause any further departures from the baseline (or from management objectives). Initially, using a combination of survey data, commercial catch information and the distributions of associated fishing effort data, predictions could be made of the number and size of RTCs required to achieve the objective and to test that other equivalences were also achieved.

After the implementation of the scheme, ongoing monitoring of catches and associated effort distribution would be maintained. The success of the scheme in achieving the objective could be evaluated during routine assessments of the stock (exploitation pattern and rate) and from survey data or commercial catches (species composition).

Data requirements

The most important data requirement is catch information linked to fine scale effort information. Real time fishing effort distribution data is potentially available from a variety of sources – Vessel Monitoring Systems (VMS), Automatic Identification System (AIS), bespoke Global Positioning Systems (GPS) and also from REM (remote electronic monitoring) associated with CCTV systems. Systems delivering data at high frequency provide for more robust schemes and various filtering is usually required to ensure that only incidences of actual fishing are included in the analysis. The required catch information associated with the effort would then depend on the issue for which the ongoing RTC scheme was set up as summarised in table 5.2.2.1.

Table 5.2.2.1 Equivalence issues and corresponding data needs

Equivalence Issue	Data
Exploitation pattern (avoid juveniles/spawners)	Size composition measurements of catch
Exploitation rate	Weight of catch
Species composition	Observed species composition of catch

It should be noted that while catch weight information is more readily available from vessel landing declarations, size and species composition monitoring requires considerably more work and implies a need for observers, self-sampling, CCTV monitoring or a combination of these.

Unlike other candidate approaches, a key requirement for RTCs is highly efficient data collection, recording, processing and analysis facility in order to generate information in 'real time'. Once established, the RTC scheme would require ongoing commitment to maintain output and to disseminate information.

RTC schemes are unlikely to be relevant or appropriate in addressing most benthic habitat protection issues. Furthermore, in situations where an alternative approach was required to address a fish stock equivalence issue caused by the adoption of a gear that departed from the baseline *and* that gear also had a greater benthic impact and affected habitat equivalence, then

an RTC solution would be unlikely to be ever be suitable as an alternative approach. This is because in responding to the changing distribution of the fish population, there would be no control over the locations at which the fishing activity took place and potential damage to the seabed would be unpredictable.

5.2.3. Case Study

An example of the application of the RTC approach is their use in the Scottish Conservation Credits Scheme. In this case the requirement was for a measure that would reduce the capture of cod and contribute to the required reductions in fishing mortality rate (to provide equivalence in line with the prescribed effort reductions in the EU 'cod plan'). Using aggregate information built up from individual vessel cod landings linked to the associated vessel fishing positions (from VMS), density maps were constructed using a grid of rectangles. The dimensions of the rectangles were equivalent to the size of RTCs. The rectangles with the highest abundances were then designated as RTCs – 12-15RTCs were in place at any one time. The process was repeated every 21 days and the overall number of RTCs throughout the year was designed to reduce the cod catch by the required amount. Figure 5.2.3.1 shows the overall distribution of RTCs in 2011, this distribution closely reflects the distribution of cod observed in international surveys in recent years Figure 5.2.3.2 Details and discussion of the method can be found in Holmes et al (2009) and Holmes et al (2011).

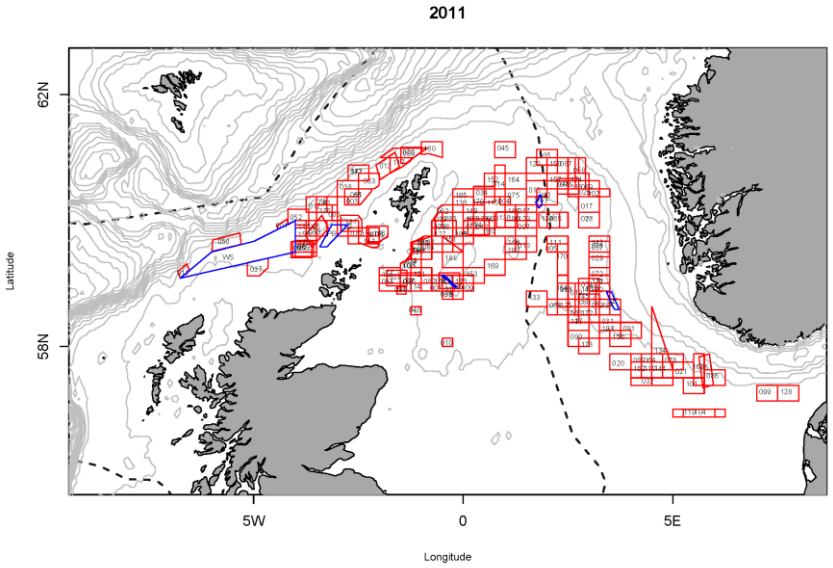

Figure 5.2.3.1 Distribution of Real Time Closures (red boxes = RTCs) in the Scottish Conservation Credits Scheme during 2011. The figure also shows spawning closures (small blue areas and the large permanent EU closure to the west of 4°W

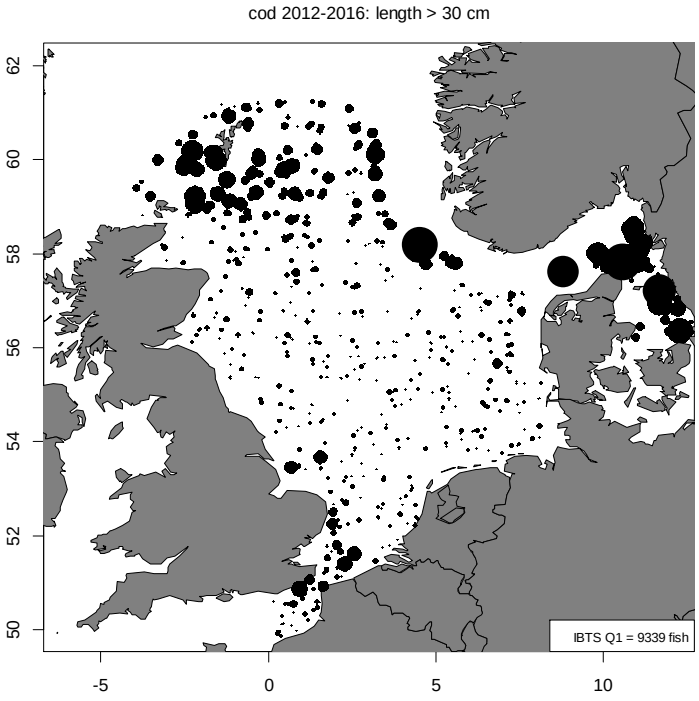

Figure 5.2.3.2 Distribution of cod from IBTS surveys 2012-2016

While this approach offers flexibility and responsiveness to distributional changes, the real-time data requirements, ongoing analysis and management requirements imply a considerable overhead and commitment. In addition, the usual legislative and enforcement processes do not always lend themselves to such transitory measures. Regulatory arrangements involving administrative penalties may be more appropriate.

Detailed evaluation of the effectiveness of the RTC approach may also be problematic, since this requires both knowledge of the fish populations within the closure and continuing information about the activity of any displaced vessels. In practise the most straightforward analysis relies on the general assessment of the state of the stock which is most likely a product of a combination of measures. Attempts to evaluate the impact of RTCs in the Scottish Conservation Credits Scheme were reported in STECF reports using methods described in Needle and Caterino (2011)

There are examples of Real Time tools which do not involve the establishment of closures or formal regulation. For example in the Georges Bank, avoidance of yellowtail flounder in the scallop fishery is facilitated using an abundance or 'heat' map approach where fishermen's catch rates of the unwanted species are collated and fed back to the fleet so that fishing activity can be directed towards areas of lower abundance(Wright et al., 2014). However, it is unclear how these approaches could provide confidence that equivalence could be achieved.

5.3.Results-based management (RBM)

5.3.1. Description

Results based management (RBM) is a management scheme, where the responsibility of the fishery shifts from managers to fishermen. When applied, the fishery is managed by the output of the fishery, rather than regulating how, where and when to fish. In practice, no or few restrictions would be imposed on the fishing practice; however limitations on extractions rates or extraction patterns are imposed to meet management targets. Considering a change to RBM to offset a deviation from the baseline technical measures, aims to create an economic incentive for the fishermen to optimize their catches in relation to management plans and targets.

A basic assumption in RBM is that output reports are truthful and include the entire catch of all species at a haul by haul level, along with spatial information on the catch. This is typically referred to as a fully documented fishery (FDF). In FDF, catches are usually verified by an

increased monitoring of catches, through dock-side port sampling or on-board observers (US West Coast Groundfish fishery). However, as verification coverage needs to be substantially higher than in input-based management schemes, Remote Electronic Monitoring (REM) has proven to provide a cost-effective verification tool to enable full and real-time coverage of the fishery (Mortensen *et al.*, 2016; van Helmond *et al.*, 2015).

5.3.2. Measuring equivalence

Prior to considering RBM as a mitigation tool for a deviation from baseline technical measures, equivalence or optimized performance in the switch to RBM, to comply with management targets within the criteria of size composition, total mortality, species composition needs to be estimated. Mitigation of habitat effects are not likely to be achieved through a switch to RBM and other measures should be considered in cases where the proposed alternative technical measure does not have an equal habitat effect as baseline technical measures.

Analysis and evaluation

A suggested approach to demonstrate equivalence potentially affected by a switch to RBM would be to provide a risk-based analysis of the possible outcome of the deviation from the baseline measure within the framework of the RBM scheme. Possible changes in fleet dynamics and tactical decisions of the individual vessels should be assessed as a result of the new management scheme.

In regards to species with a Total Allowable Catch (TAC), it should be estimated what species and size classes, vessels would target to optimize their catch value. Additionally, a risk profile on the likelihood of vessels acting against management plans and targets, should be evaluated, e.g. the risk of vessels overexploiting juveniles or individuals below minimum conservation reference size (MCRS). Practically, this means that proponents should provide sufficient documentation, in terms of risk assessment, that, although a switch to RBM allows fishermen to exploit size classes not intended for exploitation in the management targets, the likelihood of the fishermen doing so would be low, as there would be a strong economic incentive for them to exploited size classes according to management plans.

For non-TAC species and non-TAC managed areas, along with protected species, a similar risk-assessment as with TAC species should be performed. However, as the fishery is not restricted by a TAC, other types of output limitations should be considered to be implemented in the risk-assessment and proposal. These limitations could be percentage limitations, restricting the catch composition to not contain more than a certain percentage of a certain species; ratio limitations, where the ratio between two or more species should not be more or less than a fixed ratio; temporal output limitation, restricting the daily, weekly or monthly output of a vessel or fleet to a certain amount; other limitations.

Lastly, for both TAC and non-TAC species and areas, a proposal on output monitoring needs to be included, which should be sufficient to estimate if the aims of the existing management plans or the overarching aims of the conservation objectives of the Common Fisheries Policy are meet. Additionally, trigger mechanisms should be established in case fishery outputs deviate from the aims. Output monitoring could be comprised of real-time monitoring of exploitation rate and pattern along with spatial information.

Data requirements

Considerations on data requirements to perform this analysis should therefore include populations structure of affected species, management targets and plans, market value of individual size classes and species, parameters for the range of possible gears or other deviations from the BTM, fleet composition information, etc.

5.3.3. Case Study

Mesh size flexibility in the Baltic cod fishery

Due to a population structure change in the Baltic cod stock, the reduction in the size of cod has resulted in a desire from Danish fishermen to reduce mesh size from the current baseline of 120 mm. However, as yet fishermen cannot agree on what the reduced single mesh size should be. This is a result of differences in individual quota available to vessels. Therefore, the Danish industry is exploring the possibilities of replacing mesh size and associated regulations with a RBM system. In this case fully documentation of catches would offset any negative effects of removing technical rules.

Initially, the proponents would have to evaluate the plausible range of gears or measures that could be employed under the new management scheme and subsequently evaluate different scenarios of how the gears or measures could affect exploitation rate, pattern and species composition. In addition a risk assessment of each scenario occurring, given the current TAC levels, market prize of involved species and knowledge of fleet dynamics and tactical decisions would be required. A worst and best case scenario should be included in the evaluation to mark the risk boundaries of the switch to RBM.

The results from a simulated risk-analysis shows that removing restrictions on mesh size could result in a worst case scenario, where all fishermen adopt unselective gears, which results in an over exploitation of juveniles and high catches of fish below MCRS. However the risk of fishermen adopting the worst case scenario is extremely low, as it would result in a significant reduction in profitability, as the majority of catches would have to be sold for non-human consumption for a significantly lower price per kilo. The most likely scenario estimated from the risk-assessment shows that fishermen would be more likely to adopt 100mm mesh sizes for vessels with high cod/plaice quota, which can sustain a higher bycatch of plaice and want to retain a high exploitation rate, while vessels with a lower plaice quota would adopt 110 mm mesh sizes with flatfish escape panels. The likely scenario is assessed to increase the exploitation rate of cod just above MCRS, even though the TAC would constrain the total mortality at Fmsy.

As the risk-assessment displays sufficiently low risk of fishermen adopting unselective gear, STECF may decide to give a positive assessment. However, to decrease the likelihood of fishermen adopting unwanted solutions, a lower limit of mesh size on 90 mm could be advised as a safeguard. An output monitoring scheme could also be advised, suggesting that all vessels wishing to make use of the deviation from the baseline measures in favour of FDF with REM and control agencies would be subject to increased inspection. Inspection of vessels suspected of infringement would increase to 100%, until sufficient documentation of non-infringement could be demonstrated. Penalties for infringements could also be put in place, along with trigger mechanisms in case output does not meet management targets, (e.g. continuously high catches of juveniles/protected species/others).

5.4.Reductions in fishing effort

5.1.1. Description

In certain circumstances or in specific fisheries changes in overall fishing effort could be used as a tool to replace a baseline gear or to mitigate against any detrimental effects arising from the use of a new technical measure. If, for instance, the new technical measures resulted in a change in catchability, varying fishing effort may allow stabilization of the resulting fishing mortality. Similarly, following changes in selectivity (resulting in the capture of more juveniles), an adjustment (decrease) of fishing effort could help maximize long-term yields. However, the resulting yield would be lower than the maximum yield that could be obtained with the gear before modification. Finally, if a new technical measure is shown to alter the structure and function of habitats, reducing overall fishing effort could reduce the duration of exposure to the fishing gear or technique and allow for recovery of the habitat.

5.1.2. Measuring equivalence

Reductions in fishing effort are relevant to addressing issues associated with 3 of the 4 equivalences in Table 3.2.1. In relation to size composition/exploitation pattern and total mortality/exploitation rate and species composition issues, similar methods and data can be used to establish and evaluate a fishing effort regime. The criteria relating to species composition is not relevant, while for habitat effects broadly similar methods and data are required as for spatial and temporal closures.

Analysis and evaluation

An effort reduction proposal would need to be able to demonstrate that the establishment of the effort regime would deliver the required 'correction' to ensure equivalence to the baseline or a desired management objective and that it would not disrupt the management objectives. For the exploitation rate, it would be useful to quantify the amount of fishing effort reduction needed to arrive at a fishing mortality level producing the maximum yield associated with the new selectivity pattern. This could be obtained from simulations or predictions of the changes in yield per recruit would be required. For the exploitation rate, knowledge of change in catchability will be needed together with the selection parameters, in the case of a gear-based measure. Regarding habitat, maps of habitat and distribution of effort may allow to estimate changes of effort to allow recovery of that habitat. For the ex-post evaluation, monitoring of catches and outputs from stock assessments would suffice.

Data Requirements

Several sources of information will be needed to demonstrate equivalence of an effort based approach. These would include data appropriate for yield per recruit analysis as well as selection parameters for new gears. For habitat effects the data requirements would be similar as for the spatial closure analysis.

5.5.Minimum conservation reference sizes

5.5.1. Description

In addition to the introduction of alternative gears as well as other alternative measures such as spatial and temporal measures, the Commission technical measures proposal allows for the possibility to amend the baseline minimum conservation reference sizes set at regional level as well as establishing new minimum conservation reference sizes. In doing so the proposal states that the objective of ensuring the protection of juveniles of marine species must be respected in line with the objectives of the CFP.

In this context, the requirement to land all fish below MCRS under the landing obligation does introduce a strong economic incentive to avoid such unwanted catches as they will consume available quota and/or will create difficulties of storage without economic benefit. As such, applying MCRS could offer a tool to encourage avoidance of areas with elevated levels of juveniles or to use gears with appropriate selectivity. However, application of MCRS across a broad range of species in complex mixed-species fisheries may result in substantial uptake in catches below MCRS if not appropriately aligned with the selectivity characteristic of the main gears. A combination of these factors may act as a reason for Member States to seek to amend the existing baseline MCRS or remove them altogether and replace them with alternative measures. Alternatively, responding to market pressures, Member States may consider increasing MCRS to avoid glutting the market with small fish just above the existing MCRS and encourage fishermen to fish more selectively.

5.5.2. Measuring equivalence

In assessing a proposal to amend a baseline MCRS, EWG 16-14 considers that the first step in the approach is to identify whether the amended MCRS size still meets the overall objective of the protection of juveniles. If not then then STECF may suggest Member States provide details of

accompanying measures that will ensure that this overarching objective continues to be met. These could either be a gear-based measure which increases selectivity to a level related to size at first maturity and which will ensure a reduction in catches of juveniles or could be in the form of a non-gear based measure such as a spatial or temporal closure that would protect juveniles in a certain area or areas. Reductions in fishing effort to reduce fishing mortality on juveniles of a particular species could also be considered.

Assessment of such measures should follow the same methodology as set out previously. Metrics to be used to assess this may be determined through the anticipated reduction in fishing mortality on juveniles to a specified rate (i.e. % of fish < MCRS before and after introduction of the change in MCRS). This can be monitored in the longer term by measuring the proportion of the undersized fraction in the total catch. The disadvantage of this is that it is highly sensitive to population structure and may give an overall positive or negative impression of whether the alternative work is working or not. This information should be readily available from DCF, dedicated observer data, port sampling and also from last-haul analysis.

For those stocks that do not currently have a MCRS, the EWG considers that supporting information to justify the introduction of a new MCRS should inform the decision on whether to accept such a provision on the basis that it is likely to achieve the stated objectives. Such information, where possible, should include results of simulations as well as data showing the size distribution of the relevant stocks and the relationship with the selectivity of the gears used in the fishery or fisheries.

5.6.Pros and Cons of the different types of measures

The pros and cons of each of the different measures, as well as the data requirements and evaluation indicators are summarised in table 5.7.1.

Table 5.7.1 A summary of the main pros and cons of the different non-gear based measures

Description	**Data requirements for demonstrating equivalence**	**Pros**	**Cons**	**ex-post indicators of equivalence**
Spatial closures	Location and relative abundance of fish within the closed area Recent distribution of effort Estimation of the potential quantity of fish at size protected in the closed area Simulations of the impact on size composition	Easy to implement and control Effective measure especially in areas where only effort control is applied	Difficulty to assess impacts Can create conflicts among fleets using different gears Can lead to displacement of effort into other areas	Relative fishing mortality before and after the closure Length/age distribution of catch or average length of catches
Real time closures	Size composition measurements of catch Weight of catch observed by species	Responsive to distributional change Capable of effectively targeting areas with greatest problem	Data hungry Requires efficient and highly responsive data support systems Requires	Changes in length/age distribution of catch or average length of catches Effort distribution

		Offers flexibility to fishermen Avoids long term 'no go' areas Involves fishermen and fisheries data in the management process on day to day basis	significant ongoing commitment by all parties Difficult to evaluate	
Temporal closures	Information on the timing of recruitment or spawning Distribution and temporal variations in fishing effort Estimation of the potential quantity of fish at size protected by the closure and increase in SSB as a result of the closure	Easy to implement and control Effective measure especially in areas where only effort control is applied	Difficulty to assess impacts Can create conflicts among fleets using different gears Can lead to displacement of effort into other areas	Changes in Length/age distribution of catch or average length of catches Effort distribution
Results-based management	Size composition of catch Distribution and temporal variations in fishing effort	Allows for the adoption of simpler regulations as many technical rules are not required Results in complete output documentation and control. Based on incentives rather than control	Output reports need to be completely truthful and verifiable. Safeguards are needed in order to ensure unintentional and accidental damaging effects on the stocks and environment do not occur Monitoring can be time-consuming	Relative fishing mortality before and after the introduction of RBM Length/age distribution of catch or average length of catches Effort distribution Changes in fleet dynamics
Reductions in fishing effort	Fishing mortality before and after the introduction of the measure Distribution and temporal variations in fishing effort	Relatively easy to enforce and monitor Potential to maximize yields	Blunt instrument that may be unpopular with fishermen Difficult to assess impacts Unlikely to be effective in isolation	Changes in exploitation patterns (Yield per recruit) Effort distribution Changes in fleet dynamics
MCRS	Size distribution of the relevant stocks	Straightforward measure	Difficult to assess impacts	Proportion of the undersized

	and the relationship with the selectivity of the gears used Reduction in fishing mortality on juveniles	May garner industry support particularly in cases where mcrs is reduced or abolished	Highly sensitive to population structure changes	fraction in the total catch

6. ECOSYSTEM AND ECONOMIC IMPACTS

In introducing any alternative measure there may be unintended impacts that should be considered. These mainly relate to ecosystem and economic impacts. The EWG has commented on both of these although a more detailed analysis may be required to determine in what circumstances these impacts are relevant or not in the assessment process.

Ecosystem impacts

EWG 16-14 considers that while the introduction of an alternative measure may have unintended ecosystem impacts such as on non-target species or sensitive habitats, in reality assessing all of these potential impacts will be very difficult and may not always be necessary. Therefore there needs to be a trade-off between the conservation benefits of the alternative measure and the potential for ecosystem impacts where information to allow a complete assessment is unavailable or the likely impacts are likely to be minimal. On the other hand on the basis of results of experiments, a gear may be assessed as having a lower impact than the baseline gear but may in fact still have significant impacts on the seabed due to a lack of clarity about the baseline gear the alternative gear is being tested against. The granting of an authorization to use such gears in both cases could lead to irreversible impacts on the habitat.

In cases where it is clear that an assessment of the likely bottom impacts of a new gear should be assessed then EWG 16-14 suggest the approach developed by Rijnsdorp et al (2016) should be followed. They present a quantitative framework to assess the impact of mobile fishing gear on the seabed and benthic ecosystem. The framework provides indicators for both trawling pressure and ecological impact. It builds on high-resolution maps of trawling intensity and considers the physical effects of trawl gears on the seabed, on marine taxa, and on the functioning of the benthic ecosystem. The impact of the different components of the gear (i.e. otter boards, twin-rig clump weight, groundgears and sweeps) on the benthic community is quantified using a biological-trait approach that considers the vulnerability of the benthic community to trawl impact (e.g. sediment position, morphology), the recovery rate (e.g. longevity, maturation age, reproductive characteristics, dispersal), and their ecological role. The framework has been tested in three main seabed habitat types in the North Sea to compare the indicators for pressure and ecological impact. The framework provides an overview of metrics for the physical impact of bottom trawling on the seabed and indicators for assessing the pressure of trawling and the ecological impact. This is shown in Table 6.1.

Table 6.1 Overview of metrics for the physical impact of bottom trawling on the seabed and indicators for pressure of trawling and the ecological impact (Rijnsdorp et al. 2016)

Metrics for the physical impact on the seabed Ip penetration depth of the gear component Ic impulse momentum of the collision of the gear element Is sediment mobilization Pressure indicators P1 Proportion of the habitat that is not trawled during a year P2 Proportion of the habitat that is trawled less than once in a year P3 Proportion of the habitat where 90% of the trawling effort is concentrated *Indicators for the ecological impact* E Reduction in the surface area where the community, or a specific functional group, is in its undisturbed reference state

Economic impacts

EWG 16-14 has not factored in the economic impacts of introducing alternative measures. It is assumed that Member States nationally and regionally in conjunction with their respective fishing industries in bringing forward such measures will have already considered the economic implications. It is highly unlikely that Member States would purposely introduce a measure that would have negative economic consequences for fishermen as by doing so would reduce the

incentive for uptake and compliance with the measure. This is particularly the case with measures such as spatial and temporal closures or the use of effort reductions which by their nature suggest limitations or restrictions on fishing activity.

7. CONCLUSIONS

The main conclusions of EWG 16-14 are split into general conclusions relating to the approach and methodology for evaluating alternative measures and specific conclusions relating to the gear-based and non-gear based measures.

General conclusions

- The introduction of flexibility into the technical measures proposal is a welcomed step and EWG 16-14 notes that the possibilities for the introduction of alternative measures included in the proposal is wide.
- There are clear linkages with the adoption of alternative gears and measures to the objectives of the landing obligation. To this end, it is important there is flexibility within the regulatory framework to allow fishermen to adapt their gears and operations to improve selectivity and avoid, unwanted catches and that the evaluation and monitoring process is as straightforward as possible.
- Defining clearly the objective for any proposed alternative measure is an important first step. Having a clear management objective to acheive equivalence or better with an alternative measures or measures will help in defining the approach taken to demonstrate equivalence but also in the assessment of whether equivalence has been acheived.
- Equivalence is hard to define so therefore assessing any proposed alternative measure needs to be completed on a case-by-case basis. EWG 16-14 has identified four main criteria to measure equivalence in terms of exploitation pattern, exploitation rate, species composition and habitat effects. Depending on the measure involved these criteria have a greater or lesser importance.
- The assessment of equivalence will be different depending on the objective of the measure, the complexity and level of deviation from the baseline measure and also the nature of the fishery in which it is to be used.
- EWG 16-14 suggests that as a general principle where, in the event of a limited initial trial, there is a greater need to put in place close monitoring of the outcome together with the ability to rapidly halt the use of the measure. This would compare with a situation where a high quality and exhaustive trial had demonstrated the suitability of a new measure and where ongoing monitoring was more 'light touch' and less demanding. There is often a tendency to delay implementation of a new measure where an element of controversy repeatedly leads to requests that 'more science' is carried out. Trialling followed by careful monitoring of outcomes in a controlled fishery may be a more helpful approach.
- In assessing any alternative measures there is a need to balance the requirement for rigouros/robust information and analysis without being overly prescriptive on the types or amount of supporting evidence that is required to support a proposal to use alternative measures. It is important not to stifle innovative inadvertantly.
- The focus of alternative measures will most likely be different depending on the regions. For instance the mixed demersal fisheries in NWW and the North sea as well as the cod fisheries in the Baltic lend themselves to the introduction of selective gears as potential solutions to bycatch problems, whereas in the SWW and Mediterranean the focus may be more on the introduction of permanent or temporary closed areas and the management of fishing effort, given the complexity of the fisheries and the number of species involved.
- It is highly likely that in some cases a combination of measures may be needed to acheive equivalence as the introduction of a single measure (for instance a gear change) may introduce unintended consequences. The mitiagtion of these unintended consequences will need further measures (for instance a closed area) to be introduced.
- While the introduction of an alternative measure may have unintended ecosystem impacts such as on non-target species or sensitive habitats, in reality assessing all of these potential impacts will be very difficult. A balance needs to be struck between the conservation benefits of the alternative measure and the potential for ecosystem impacts where information to allow a complete assessment is unavailable. In such cases where there is doubt the requirement for montoring and continued evaluation should be a pre-requisite.
- EWG 16-14 does not consider there is a need to assess the economic impacts of introducing alternative measures. It is assumed that Member States in conjunction with

their respective fishing industries in bringing forward such measures will have already considered the economic implications.

Gear-based measures

- There are many metrics that can be used to evaluate the efficacy of a new or modified gear. It is important that when choosing a particular metric that it is measurable and reflects the aims and objectives that have motivated the introduction/development of the gear in question. The nature of the data that is available will dictate the choice of metric but also, the chosen metric will influence what type of data needs to be collected and what experimental trials need to be carried out (if any).
- In the case of complex gear-based measures which have been demonstrated to have positive conservation benefits it is important that the definition of these gears in legislation is not verly complex and prescriptive but focuses on the central constructional elements that are important from a selectivity perspective. In this regard the use certification/authorisations attached to the use such gears could be considered. This would avoid the need for detailed definitions in legislation.
- There are a wide range of tools available for the evaluation and continued monitoring of alternative gears once introduced including self-sampling, observer programmes, REM, last-haul analysis and modelling techniques. All of these have their pros and cons and it is likely a combination of tools will be needed to monitor the impacts of alternative gears.

Non-gear based measures

- Demonstrating equivalence for non-gear based measures is much more difficult than for selective gears. The assessment of these types of measures is complex and require significant amounts of data to allow proper evaluation and continued monitoring.
- The use of spatial and temporal measures may have unintended consequences in that by closing areas to fishing either permanently or temporarily could led to displacement of effort into other areas and also the possibility of creating gear conflicts between static gear and towed gears.
- Real-time closures represent a flexible and highly responsive management measure that in the past has found favour with fishermen. However, the impact of real-time closures is difficult to assess and they require a singinifcant amount of monitoring as evidence by the Scottish Conservation Credit Scheme.
- While RBM offers the possibility to deviate from the baseline measures completely, removing the need for technical rules, it is likely that some safeguards will be needed to ensure that unintentional and accidental damaging effects on the stocks and environment do not arise. These safeguards should maintain minimum precautionary requirements for gears and practices, while setting the requirements low enough for fishermen to adjust their fishery to operate under an RBM system.
- In establishing or amending MCRS the primary objective of ensuring the protection of juveniles of marine organisms and at the same time maximizing the potential of the resource by changing the exploitation pattern should be maintained. The metrics to be used to measure protection of juveniles should be clearly defined. For example protection of juveniles may be determined through the reduction in fishing mortality on juveniles to a specified rate.
- For those stocks that are not currently subject to an MCRS, supporting information to justify the introduction of a MCRS would inform the decision on whether to accept such a provision and that such information should accompany the proposal. The EWG considers that proposals should provide information to demonstrate that the introduction of the proposed MCRS is likely to achieve the stated objectives.

8. NEXT STEPS

STECF EWG 16-14 has completed an initial evaluation of the methodologies and data needed to demonstrate equivalence of alternative measures to baseline measure specified in legislation. However, particularly in respect of the non-gear based measures EWG 16-14 stresses that further work is needed to refine this into a framework that Member States could follow in proposing such alternative measures. In this regard, EWG 16-14 suggests a follow-up meeting of the EWG should be convened. Given the proposal for the technical measures framework is still under negotiation this follow-up meeting should only be held when there is a clearer picture of the detail of the final technical measures regulation.

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10. CONTACT DETAILS OF EWG-16-XX PARTICIPANTS

[1] - Information on EWG participant's affiliations is displayed for information only. In any case, Members of the STECF, invited experts, and JRC experts shall act independently. In the context of the STECF work, the committee members and other experts do not represent the institutions/bodies they are affiliated to in their daily jobs. STECF members and experts also declare at each meeting of the STECF and of its Expert Working Groups any specific interest which might be considered prejudicial to their independence in relation to specific items on the agenda. These declarations are displayed on the public meeting's website if experts explicitly authorized the JRC to do so in accordance with EU legislation on the protection of personnel data. For more information: http://stecf.jrc.ec.europa.eu/adm-declarations

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11. List of Annexes

Electronic annexes are published on the meeting's web site on:
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List of electronic annexes documents:

EWG-16-14 – Annex 1 – COM(2016) 134. Proposal for a regulation of the European Parliament and of the Council on the conservation of fishery resources and the protection of marine ecosystems through technical measures, amending Council Regulations (EC) No 1967/2006, (EC) No 1098/2007, (EC) No 1224/2009 and Regulations (EU) No 1343/2011 and (EU) No 1380/2013 of the European Parliament and of the Council, and repealing Council Regulations (EC) No 894/97, (EC) No 850/98, (EC) No 2549/2000, (EC) No 254/2002, (EC) No 812/2004 and (EC) No 2187/2005-
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12. List of Background Documents

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List of background documents:

EWG-16-14 – Doc 1 - Declarations of invited and JRC experts (see also section 10 of this report – List of participants)

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